[Volume IV, Appx00967 – Appx03717]

Nos. 22-1972, -1973, -1975, -1976

IN THE
United States Court of Appeals
FOR THE FEDERAL CIRCUIT

MASIMO CORPORATION,

Appellant,

v.

APPLE INC.,

Appellee.

APPEAL FROM THE PATENT TRIAL AND APPEAL BOARD
CASE NOS. IPR2020-01713, IPR2020-01716, IPR2020-01733, IPR2020-01737

JOINT APPENDIX

Joseph R. Re, *Principal Counsel*
Stephen C. Jensen
Jarom D. Kesler
Stephen W. Larson
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
(949) 760-0404

Jeremiah S. Helm
KNOBBE, MARTENS, OLSON & BEAR, LLP
1717 Pennsylvania Ave., N.W.
Washington, D.C. 20006
(202) 640-6400

Attorneys for Appellant Masimo Corporation

Lauren A. Degnan, *Principal Counsel*
Christopher Dryer
W. Karl Renner
FISH & RICHARDSON P.C.
1000 Maine Ave., Suite 1000
Washington, DC 20024
Tel: (202) 783-5070

Ashley Bolt
FISH & RICHARDSON P.C.
1180 Peachtree Street NE
21st Floor
Atlanta, GA 30309
Tel: (404) 892-5005

Attorneys for Appellee Apple Inc.

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57601247

Trials@uspto.gov
571-272-7822

Paper 33
Entered: May 4, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

MASIMO CORPORATION,
Patent Owner.

IPR2020-01737
Patent 10,709,366 B1

Before JOSIAH C. COCKS, ROBERT L. KINDER, and AMANDA F. WIEKER, *Administrative Patent Judges.*

KINDER, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

Case: 22-1972 Document: 33 Page: 49 Filed: 08/19/2022

I. INTRODUCTION

A. Background

Apple Inc. ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1–27 ("challenged claims") of U.S. Patent No. 10,709,366 B1 (Ex. 1001, "the '366 patent"). Paper 2 ("Pet."). Masimo Corporation ("Patent Owner") waived filing a Preliminary Response. Paper 6. We instituted an *inter partes* review of all challenged claims 1–27 on all asserted grounds of unpatentability, pursuant to 35 U.S.C. § 314. Paper 7 ("Inst. Dec.").

After institution, Patent Owner filed a Response (Paper 15, "PO Resp.") to the Petition, Petitioner filed a Reply (Paper 19, "Pet. Reply"), and Patent Owner filed a Sur-reply (Paper 22, "Sur-reply"). An oral hearing was held on February 9, 2022, and a transcript of the hearing is included in the record. Paper 32 ("Tr.").

We issue this Final Written Decision pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons set forth below, Petitioner has met its burden of showing, by a preponderance of the evidence, that challenged claims 1–27 of the '366 patent are unpatentable.

B. Related Proceedings

Masimo Corporation v. Apple Inc., Civil Action No. 8:20-cv-00048 (C.D. Cal.) (filed Jan. 9, 2020);

Apple Inc. v. Masimo Corporation, IPR2020-01520 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,258,265 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01521 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,292,628 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01523 (PTAB Sept. 9, 2020) (challenging claims of U.S. Patent No. 8,457,703 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01524 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,433,776 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01526 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 6,771,994 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01536 (PTAB Aug. 31, 2020) (challenging claims 1–29 of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01537 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01538 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01539 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01713 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,624,564 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01714 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01715 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01716 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,194 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01722 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01723 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2); and

Apple Inc. v. Masimo Corporation, IPR2020-01733 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,195 B1).

Pet. 94–95; Paper 3, 1, 3–4.

Patent Owner further identifies certain pending patent applications, as well as other issued and abandoned applications, that claim priority to, or share a priority claim with, the ’366 patent. Paper 3, 1–2.

C. The ’366 Patent

The ’366 patent is titled “Multi-Stream Data Collection System for Noninvasive Measurement of Blood Constituents,” and issued on July 14, 2020, from U.S. Patent Application No. 16/829,510, filed March 25, 2020. Ex. 1001, codes (21), (22), (45), (54). The ’366 patent claims priority through a series of continuation and continuation-in-part applications to Provisional Application Nos. 61/086,060, 61/086,108, 61/086,063, 61/086,057, each filed August 4, 2008, as well as 61/091,732, filed August 25, 2008, and 61/078,228 and 61/078,207, both filed July 3, 2008. *Id.* at codes (60), (63).

The ’366 patent discloses a two-part data collection system including a noninvasive sensor that communicates with a patient monitor. *Id.* at 2:38–40. The sensor includes a sensor housing, an optical source, and several photodetectors, and is used to measure a blood constituent or analyte, e.g., oxygen or glucose. *Id.* at 2:29–37, 2:62–3:12. The patient monitor includes a display and a network interface for communicating with a handheld computing device. *Id.* at 2:42–48.

Figure 1 of the ’366 patent is reproduced below.

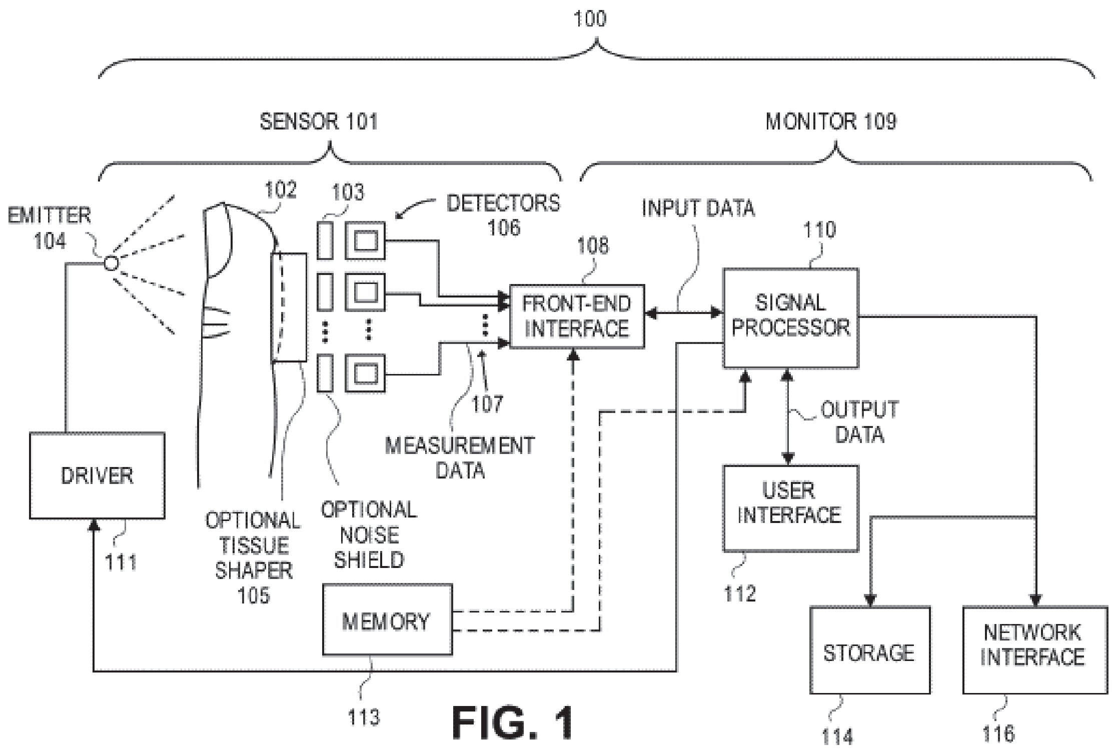

FIG. 1

Figure 1 illustrates a block diagram of data collection system 100 including sensor 101 and monitor 109. *Id.* at 11:51–61. Sensor 101 includes optical emitter 104 and detectors 106. *Id.* Emitters 104 emit light that is attenuated or reflected by the patient’s tissue at measurement site 102. *Id.* at 11:61–63; 14:4–7. Detectors 106 capture and measure the light attenuated or reflected from the tissue. *Id.* at 14:3–10. In response to the measured light, detectors 106 output detector signals 107 to monitor 109 through front-end interface 108. *Id.* at 14:7–10, 28–33. Sensor 101 also may include tissue shaper 105, which may be in the form of a convex surface that: (1) reduces the thickness of the patient’s measurement site; and (2) provides more surface area from which light can be detected. *Id.* at 10:61–11:13.

Monitor 109 includes signal processor 110 and user interface 112. *Id.* at 15:16–18. “[S]ignal processor 110 includes processing logic that

determines measurements for desired analytes, . . . based on the signals received from the detectors 106." *Id.* at 15:20–24. User interface 112 presents the measurements to a user on a display, e.g., a touch-screen display. *Id.* at 15:46–50. The monitor may be connected to storage device 114 and network interface 116. *Id.* at 15:60–67.

The '366 patent describes various examples of sensor devices. Figures 14D and 14F, reproduced below, illustrate sensor devices.

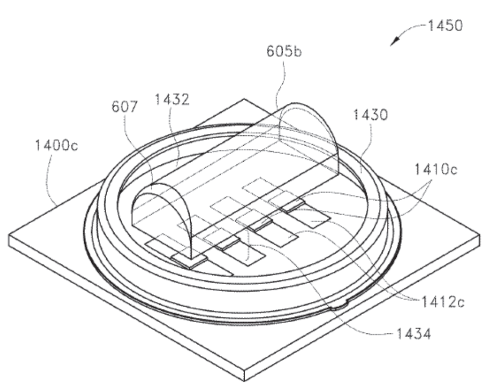

FIG. 14D

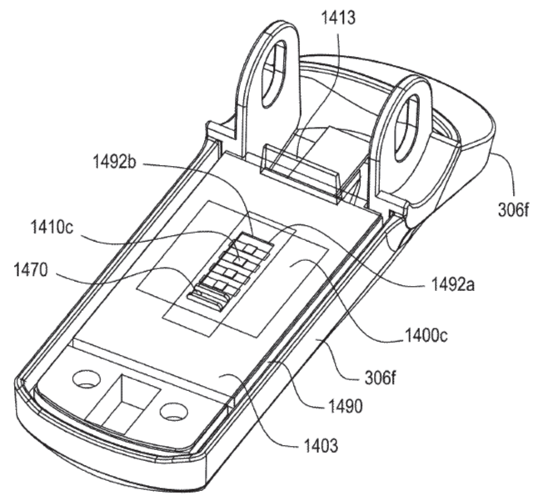

FIG. 14F

Figure 14D (left) illustrates portions of a detector submount and Figure 14F (right) illustrates portions of a detector shell. *Id.* at 6:44–47. As shown in Figure 14D, multiple detectors 1410c are located within housing 1430 and under transparent cover 1432, on which protrusion 605b (or partially cylindrical protrusion 605) is disposed. *Id.* at 35:39–43, 36:30–41. Figure 14F illustrates a detector shell 306f including detectors 1410c on substrate 1400c. *Id.* at 37:9–17. Substrate 1400c is enclosed by shielding enclosure 1490 and noise shield 1403, which include window 1492a and window 1492b, respectively, placed above detectors 1410c. *Id.* Alternatively,

cylindrical housing 1430 may be disposed under noise shield 1403 and may enclose detectors 1410c. *Id.* at 37:47–49.

Figures 4A and 4B, reproduced below, illustrate an alternative example of a tissue contact area of a sensor device.

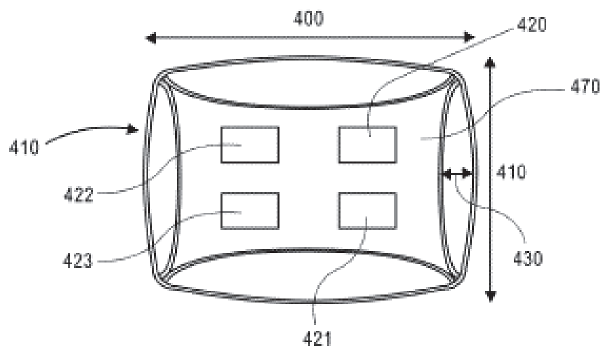

FIG. 4A

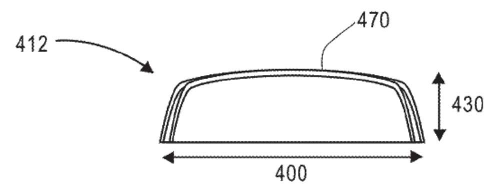

FIG. 4B

Figures 4A and 4B illustrate arrangements of protrusion 405 including measurement contact area 470. *Id.* at 23:18–24. "[M]easurement site contact area 470 can include a surface that molds body tissue of a measurement site." *Id.* "For example, . . . measurement site contact area 470 can be generally curved and/or convex with respect to the measurement site." *Id.* at 23:41–43. The measurement site contact area may include windows 420–423 that "mimic or approximately mimic a configuration of, or even house, a plurality of detectors." *Id.* at 23:49–63.

D. Illustrative Claim

Of the challenged claims, claim 1, 14, and 27 are independent. Claim 1 is illustrative and is reproduced below.

> 1. A noninvasive physiological parameter measurement device adapted to be worn by a wearer, the noninvasive physiological parameter measurement device comprising:
>
> [a] one or more light emitters;
>
> [b] a substrate having a surface;

[c] a first set of photodiodes arranged on the surface and spaced apart from each other, wherein:

[d] the first set of photodiodes comprises at least four photodiodes, and

[e] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue;

[f] a second set of photodiodes arranged on the surface and spaced apart from each other, wherein:

[g] the second set of photodiodes comprises at least four photodiodes,

[h] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue, and

[i] at least one of the first signal stream or the second signal stream includes information usable to determine a physiological parameter of a wearer of the noninvasive physiological parameter measurement device;

[j] a wall extending from the surface and configured to surround at least the first and second sets of photodiodes; and

[k] a cover arranged to cover at least a portion of the surface of the substrate, wherein the cover comprises a protrusion that extends over all of the photodiodes of the first and second sets of photodiodes arranged on the surface, and wherein the cover is further configured to cover the wall.

Ex. 1001, 44:57–45:27 (bracketed identifiers [a]–[k] added). Independent claim 14 includes limitations substantially similar to limitations [a], [c]–[h], [j], and [k] and includes additional limitations drawn to "one or more processors configured to: receive information . . . ; [and], process the information to determine physiological parameter measurement

information." *Id.* at 46:33–56. Independent Claim 27 contains numerous limitations, which are integrated from claim 1 (limitations [a]–[k]) as well as limitations from numerous dependent claims. *Id.* at 48:1–49:10; Pet. 81–84.

E. Applied References

Petitioner relies upon the following references:

> Sherman et al., U.S. Patent No. 4,941,236, filed July 6, 1989, issued July 17, 1990 (Ex. 1047, "Sherman");
>
> Ohsaki et al., U.S. Patent Application Publication No. 2001/0056243 A1, filed May 11, 2001, published December 27, 2001 (Ex. 1014, "Ohsaki");
>
> Aizawa, U.S. Patent Application Publication No. 2002/0188210 A1, filed May 23, 2002, published December 12, 2002 (Ex. 1006, "Aizawa");
>
> Goldsmith et al., U.S. Patent Application Publication No. 2007/0093786 A1, filed July 31, 2006, published April 26, 2007 (Ex. 1027, "Goldsmith); and
>
> Y. Mendelson, et al., "*Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter*," Proceedings of the 25th IEEE EMBS Annual International Conference, 3016-3019 (2003) (Ex. 1024, "Mendelson-2003").

Pet. 1–2.

Petitioner also submits, *inter alia*, a Declaration of Thomas W. Kenny, Ph.D. (Ex. 1003) and a Second Declaration of Dr. Kenny (Ex. 1060). Patent Owner submits, *inter alia*, a Declaration of Vijay K. Madisetti, Ph.D (Ex. 2004). The parties also provide deposition testimony from Dr. Kenny and Dr. Madisetti, including from this proceeding and others. Exs. 1053–1056, 2006–2009, 2026–2027.

F. Asserted Grounds of Unpatentability

We instituted an *inter partes* review based on the following grounds. Inst. Dec. 11, 33.

Claim(s) Challenged	35 U.S.C. §	References/Basis
1–12 and 14–27	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith
13	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith, Sherman

II. DISCUSSION

A. Claim Construction

For petitions filed on or after November 13, 2018, a claim shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b) (2020). Accordingly, we construe the claims according to the standard set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). Petitioner submits that no claim term requires express construction. Pet. 3. Patent Owner asserts that the claims should be given their ordinary and customary meaning, consistent with the specification. PO Resp. 9.

Based on our analysis of the issues in dispute, we conclude that no claim terms require express construction. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Matal*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

B. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103(a) if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406

(2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness.[1] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). When evaluating a combination of teachings, we must also "determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue." *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). Whether a combination of elements would have produced a predictable result weighs in the ultimate determination of obviousness. *Id.* at 416–417.

In an *inter partes* review, the petitioner must show with particularity why each challenged claim is unpatentable. *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016); 37 C.F.R. § 42.104(b). The burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must support its challenge by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

C. Level of Ordinary Skill in the Art

Petitioner identifies the appropriate level of skill in the art as that possessed by a person having "a Bachelor of Science degree in an academic discipline emphasizing the design of electrical, computer, or software

[1] The parties have not presented objective evidence of non-obviousness.

technologies, in combination with training or at least one to two years of related work experience with capture and processing of data or information." Pet. 3 (citing Ex. 1003 ¶¶ 21–22). "Alternatively, the person could have also had a Master of Science degree in a relevant academic discipline with less than a year of related work experience in the same discipline." *Id.*

Patent Owner makes several observations regarding Petitioner's identified level of skill in the art but, "[f]or this proceeding, [Patent Owner] nonetheless applies Petitioner's asserted level of skill." PO Resp. 9.

We adopt Petitioner's assessment as set forth above, which appears consistent with the level of skill reflected in the Specification and prior art.

D. Obviousness over the Combined Teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith

Petitioner contends that claims 1–12 and 14–27 of the '366 patent would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith. Pet. 10–91; *see also* Pet. Reply 8–37.[2] Patent Owner disagrees. PO Resp. 8–66; *see also* Sur-reply 1–29.

Based on our review of the parties' arguments and the cited evidence of record, we determine that Petitioner has met its burden of showing by a preponderance of the evidence that claims 1–12 and 14–27 are unpatentable.

1. Overview of Aizawa (Ex. 1006)

Aizawa is a U.S. patent application publication titled "Pulse Wave Sensor and Pulse Rate Detector," and discloses a pulse wave sensor that

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[2] Petitioner's Reply includes a Table of Contents and an Exhibits list that spans pages ii–vii, and the substance of the Reply then begins on page 8.

detects light output from a light emitting diode and reflected from a patient's artery. Ex. 1006, codes (54), (57).

Figure 1(a) of Aizawa is reproduced below.

FIG. 1 (a)

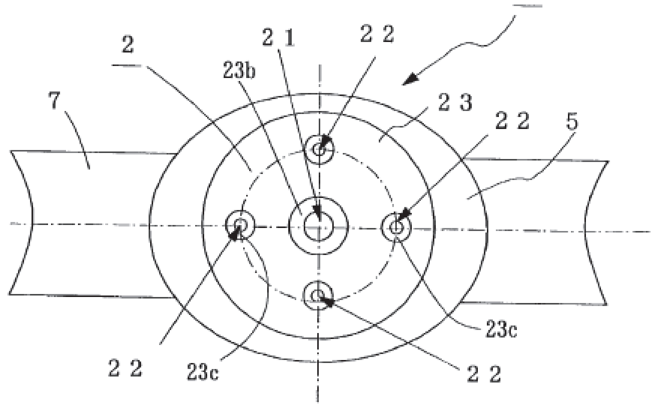

Figure 1(a) is a plan view of a pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(a), pulse wave sensor 2 includes light emitting diode ("LED") 21, four photodetectors 22 symmetrically disposed around LED 21, and holder 23 for storing LED 21 and photodetectors 22. *Id.* Aizawa discloses that, "to further improve detection efficiency, . . . the number of the photodetectors 22 may be increased." *Id.* ¶ 32, Fig. 4(a). "The same effect can be obtained when the number of photodetectors 22 is 1 and a plurality of light emitting diodes 21 are disposed around the photodetector 22." *Id.* ¶ 33.

Figure 1(b) of Aizawa is reproduced below.

FIG. 1 (b)

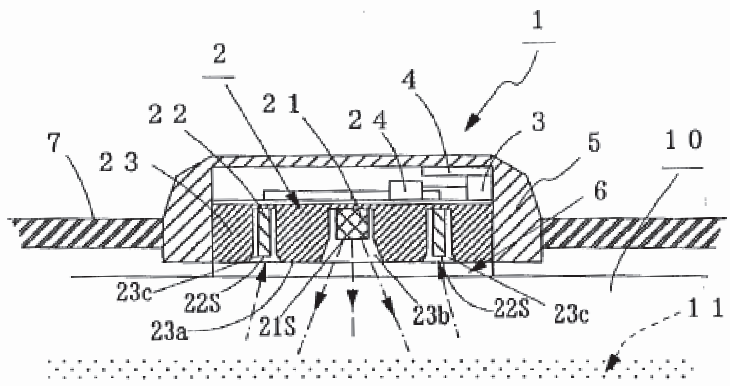

Figure 1(b) is a sectional view of the pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(b), pulse wave sensor 2 includes drive detection circuit 24 for detecting a pulse wave by amplifying the outputs of photodetectors 22. *Id.* Arithmetic circuit 3 computes a pulse rate from the detected pulse wave and transmitter 4 transmits the pulse rate data to an "unshown display." *Id.* The pulse rate detector further includes outer casing 5 for storing pulse wave sensor 2, acrylic transparent plate 6 mounted to detection face 23a of holder 23, and attachment belt 7. *Id.*

Aizawa discloses that LED 21 and photodetectors 22 "are stored in cavities 23b and 23c formed in the detection face 23a" of the pulse wave sensor. *Id.* ¶ 24. Detection face 23a "is a contact side between the holder 23 and a wrist 10, respectively, at positions where the light emitting face 21s of the light emitting diode 21 and the light receiving faces 22s of the photodetectors 22 are set back from the above detection face 23a." *Id.* Aizawa discloses that "a subject carries the above pulse rate detector 1 on the inner side of his/her wrist 10 . . . in such a manner that the light emitting face 21s of the light emitting diode 21 faces down (on the wrist 10 side)."

Id. ¶ 26. Furthermore, "the above belt 7 is fastened such that the acrylic transparent plate 6 becomes close to the artery 11 of the wrist 10. Thereby, adhesion between the wrist 10 and the pulse rate detector 1 is improved." *Id.* ¶¶ 26, 34.

2. *Overview of Mendelson-2003 (Ex. 1024)*

Mendelson-2003 is a journal article titled "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," which discusses a pulse oximeter sensor in which "battery longevity could be extended considerably by employing a wide annularly shaped photodetector ring configuration and performing SpO_2 measurements from the forehead region." Ex. 1024, 3016.[3]

Mendelson-2003 explains that pulse oximetry uses sensors to monitor oxygen saturation (SpO_2), where the sensor typically includes light emitting diodes (LED) and a silicon photodetector (PD). *Id.* According to Mendelson-2003, when designing a pulse oximeter, it is important to offer "low power management without compromising signal quality." *Id.* at 3017. "However, high brightness LEDs commonly used in pulse oximeters require[] relatively high current pulses, typically in the range between 100–200mA. Thus, minimizing the drive currents supplied to the LEDs would contribute considerably toward the overall power saving in the design of a more efficient pulse oximeter." *Id.* To achieve this goal, Mendelson-2003 discusses previous studies in which

> the driving currents supplied to the LEDs . . . could be lowered significantly without compromising the quality of the

[3] We adopt Petitioner's citation format by referring to the original page numbering and not Petitioner's added page numbering at the bottom.

> [photoplethysmographic or PPG signals] by increasing the overall size of the PD . . . . Hence, by maximizing the light collected by the sensor, a very low power-consuming sensor could be developed, thereby extending the overall battery life of a pulse oximeter intended for telemedicine applications.

Id.

Mendelson-2003 discloses the prototype of such a sensor in Figure 1, which is reproduced below, and served as the basis for the studies evaluated in Mendelson-2003.

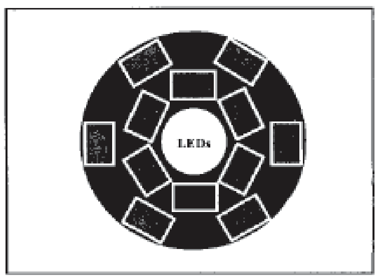

Figure 1 of Mendelson-2003 depicts a sensor configuration showing the relative positions of its PDs and LEDs. *Id.* As shown in Figure l, "six PDs were positioned in a close inner-ring configuration at a radial distance of 6.0mm from the LEDs. The second set of six PDs spaced equally along an outer-ring, separated from the LEDs by a radius of 10.0mm." *Id.* Mendelson-2003 also explains that "[e]ach cluster of six PDs were wired in parallel and connected through a central hub to the common summing input of a current-to-voltage converter." *Id.*

Mendelson-2003 reports the results of the studies as follows:

> Despite the noticeable differences between the PPG signals measured from the wrist and forehead, the data plotted in Fig. 3 also revealed that considerable stronger PPGs could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity. The additional increase, however, depends on the area and relative position of the PD with respect to the LEDs. For example,

> utilizing the outer-ring configuration, the overall increase in the average amplitudes of the R and IR PPGs measured from the forehead region was 23% and 40%, respectively. Similarly, the same increase in PD area produced an increase in the PPG signals measured from the wrist, but with a proportional higher increase of 42% and 73%.

Id. at 3019.

3. *Overview of Ohsaki (Ex. 1014)*

Ohsaki is a U.S. patent application publication titled "Wristwatch-type Human Pulse Wave Sensor Attached on Back Side of User's Wrist," and discloses an optical sensor for detecting a pulse wave of a human body. Ex. 1014, code (54), ¶ 3. Figure 1 of Ohsaki is reproduced below.

FIG. 1

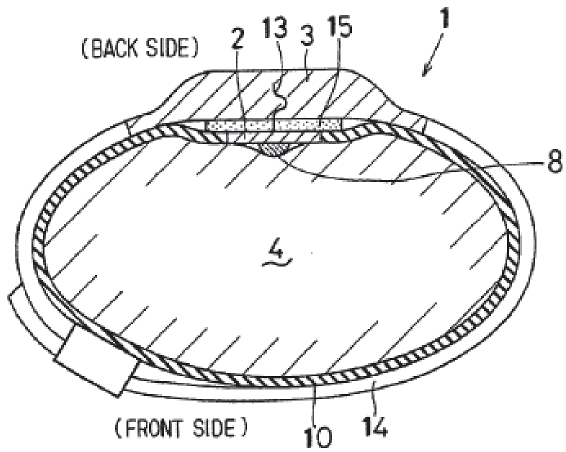

Figure 1 illustrates a cross-sectional view of pulse wave sensor 1 attached on the back side of user's wrist 4. *Id.* ¶¶ 12, 16. Pulse wave sensor 1 includes detecting element 2 and sensor body 3. *Id.* ¶ 16.

Figure 2 of Ohsaki, reproduced below, illustrates further detail of detecting element 2.

FIG. 2

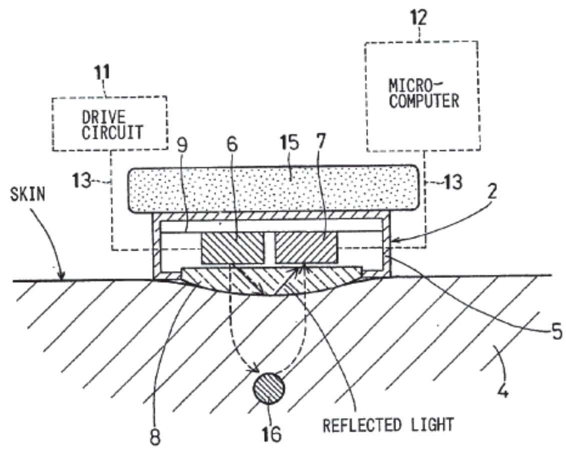

Figure 2 illustrates a mechanism for detecting a pulse wave. *Id.* ¶ 13. Detecting element 2 includes package 5, light emitting element 6, light receiving element 7, and translucent board 8. *Id.* ¶ 17. Light emitting element 6 and light receiving element 7 are arranged on circuit board 9 inside package 5. *Id.* ¶¶ 17, 19.

"Translucent board 8 is a glass board which is transparent to light, and attached to the opening of the package 5. A convex surface is formed on the top of the translucent board 8." *Id.* ¶ 17. "[T]he convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin," preventing detecting element 2 from slipping off the detecting position of the user's wrist. *Id.* ¶ 25. By preventing the detecting element from moving, the convex surface suppresses "variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin." *Id.* Additionally, the convex surface prevents penetration by "noise such as disturbance light from the outside." *Id.*

Sensor body 3 is connected to detecting element 2 by signal line 13. *Id.* ¶ 20. Signal line 13 connects detecting element 2 to drive circuit 11, microcomputer 12, and a monitor display (not shown). *Id.* Drive circuit 11 drives light emitting element 6 to emit light toward wrist 4. *Id.* Detecting element 2 receives reflected light which is used by microcomputer 12 to calculate pulse rate. *Id.* "The monitor display shows the calculated pulse rate." *Id.*

4. Overview of Goldsmith (Ex. 1027)

Goldsmith is a U.S. patent application publication titled "Watch Controller for a Medical Device," and discloses a watch controller device that communicates with an infusion device to "provid[e] convenient monitoring and control of the infusion pump device." Ex. 1027, codes (54), (57).

Goldsmith's Figure 9A and 9B are reproduced below.

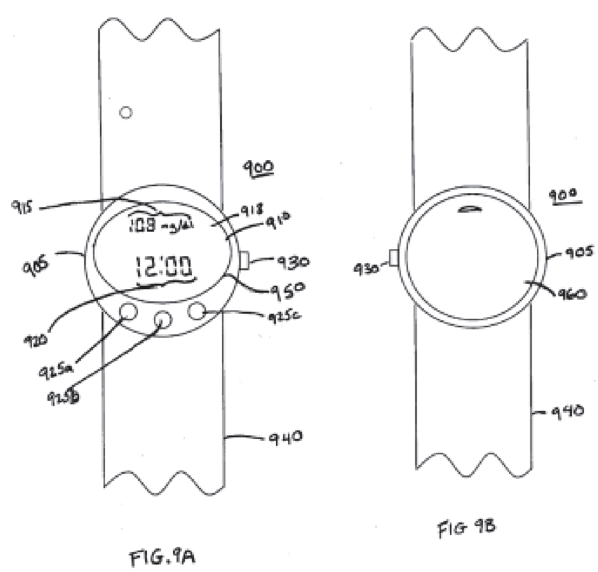

Figure 9A and Figure 9B are respective front and rear views of a combined watch and controller device. *Id.* ¶¶ 30–31. As shown in Figure 9A, watch

controller 900 includes housing 905, transparent member 950, display 910, input devices 925a–c, scroll wheel 930, and wrist band 940. *Id.* ¶¶ 85–86. Figure 9B shows rear-side cover 960, and a rear view of housing 905, scroll wheel 930, and wrist band 940. *Id*.

Goldsmith discloses the watch controller may interact with one or more devices, such as infusion pumps or analyte monitors. *Id.* ¶ 85; *see also id.* ¶ 88 ("The analyte sensing device 1060 may be adapted to receive data from a sensor, such as a transcutaneous sensor."). Display 910 "may display at least a portion of whatever information and/or graph is being displayed on the infusion device display or on the analyte monitor display," such as, e.g., levels of glucose. *Id*. ¶ 86. The display is customizable in a variety of configurations including user-customizable backgrounds, languages, sounds, font (including font size), and wall papers. *Id*. ¶¶ 102, 104. Additionally, the watch controller may communicate with a remote station, e.g., a computer, to allow data downloading. *Id*. ¶ 89 (including wireless). The remote station may also include a cellular telephone to be "used as a conduit for remote monitoring and programming." *Id.*

5. *Independent Claim 1*

Petitioner contends that claim 1 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith. Pet. 38–53. Below, we set forth how the combination of prior art references teaches or suggests the claim limitations that are not disputed by the parties. For those limitations and reasons for combining the references that are disputed, we examine each of the parties' contentions and then provide our analysis.

i. "A noninvasive physiological parameter measurement device adapted to be worn by a wearer, the noninvasive physiological parameter measurement device comprising"

The cited evidence supports Petitioner's undisputed contention that "Aizawa discloses a pulse sensor that is designed to 'detect[] the pulse wave of a subject from light reflected from a red corpuscle in the artery of a wrist of the subject by irradiating the artery of the wrist,'" and that Goldsmith teaches an analyte sensor that is part of a user-worn controller device that includes, e.g., a display.[4] Pet. 33, 39 (quoting Ex. 1006 ¶ 2); *see also* Ex. 1006 ¶ 27 (discussing optical path), Fig. 2 (depicting physiological parameter measurement device worn by a user); Ex. 1027 ¶¶ 85 ("a watch"), 88 ("analyte sensing device 1060"), Fig. 9A; Ex. 1003 ¶ 94.

Petitioner further contends that a person of ordinary skill in the art would have found it obvious to incorporate Aizawa's sensor "into Goldsmith's integrated wrist-worn watch controller device that includes, among other features, a touch screen, network interface, and storage device" in order to receive and display data sensed by Aizawa's sensor. Pet. 31–38; *see, e.g.*, Ex. 1003 ¶¶ 88–89 ("would have enhanced the sensor's utility and improved the user's experience"). According to Petitioner, this would have "enable[d] a user to view and interact with heart rate data during exercise via Goldsmith's touch-screen display, and to enable heart rate data to be monitored by the user and/or others through any of the devices with which Goldsmith's device can communicate." Pet. 34; *see, e.g.*, Ex. 1003 ¶ 89.

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[4] Whether the preamble is limiting need not be resolved because Petitioner shows sufficiently based on the final record that the recitation in the preamble is satisfied by the prior art.

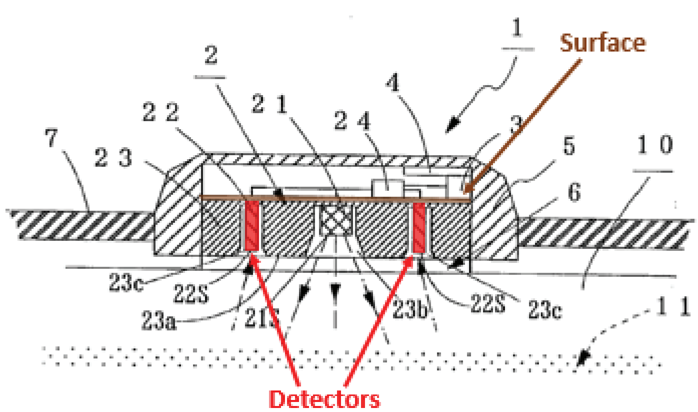
Petitioner asserts this would have been use of a known technique to improve similar devices in the same way. Pet. 35; *see, e.g.*, Ex. 1003 ¶ 90; *see also* Pet. 35–38 (also discussing physical incorporation); *see, e.g.*, Ex. 1003 ¶¶ 90–93 (same).

Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 88–94.

ii. "[a] one or more light emitters" and "[b] a substrate having a surface"

The cited evidence supports Petitioner's undisputed contention that Aizawa discloses an emitter, LED 21, that emits light that is picked up by photodetectors. Pet. 40; *see, e.g.*, Ex. 1006 ¶ 23 ("LED 21 . . . for emitting light having a wavelength of a near infrared range"), 27 (explaining that light is emitted toward the wrist), Fig. 1(b) (depicting emitter 21 facing user tissue 10), Fig. 2 (depicting sensor worn on user's wrist).

Petitioner persuasively demonstrates that a person of ordinary skill in the art would have understood that Aizawa's surface would include a substrate on which the emitter and detectors are arranged. Pet. 41. Petitioner relies on annotated Figure 1(b) of Aizawa, reproduced below.



Petitioner's annotated Figure 1(b) shows detectors highlighted in red and a substrate surface unnumbered but highlighted in brown. Pet. 41. Dr. Kenny likewise testifies that Aizawa teaches "a substrate having surface (shown in brown) on which the holder 23 is placed and on which the detectors/ photodiodes are arranged." Ex. 1003 ¶ 96.

iii. "[c] a first set of photodiodes arranged on the surface and spaced apart from each other, wherein: [d] the first set of photodiodes comprises at least four photodiodes" and "[f] a second set of photodiodes arranged on the surface and spaced apart from each other, wherein: [g] the second set of photodiodes comprises at least four photodiodes"

<u>Petitioner's Undisputed Contentions</u>

Petitioner contends that Aizawa discloses a first set of four photodiodes that are circularly arranged around a central emitter. Pet. 18 (citing, e.g., Ex. 1006 ¶ 23). Petitioner also contends that, in one embodiment, Aizawa discloses that eight or more detectors may be used to improve detection efficiency, but does not expressly teach a "second set of photodiodes," as claimed. *Id.* at 19–20 (citing, e.g., Ex. 1006, Fig. 4(a)); *see also* Ex. 1003 ¶¶ 67–68.

Patent Owner does not dispute these contentions, and we agree with Petitioner. Aizawa discloses a set of "four phototransistors 22" that are disposed in a single ring around central emitter 21. Ex. 1006 ¶ 23, Figs. 1(a)–1(b). Aizawa also discloses that "the number of the photodetectors 22 may be increased" to further improve detection efficiency, and depicts in Figure 4(a) an embodiment where eight photodetectors 22 are disposed in a single ring around central emitter 21. *Id.* ¶ 32.

Also according to Petitioner, Mendelson-2003 teaches a sensor that uses two rings of photodiodes, which improve light collection efficiency, permit use of lower brightness LEDs, and reduce power consumption. Pet. 20–21; *see also* Ex. 1003 ¶¶ 69–70.

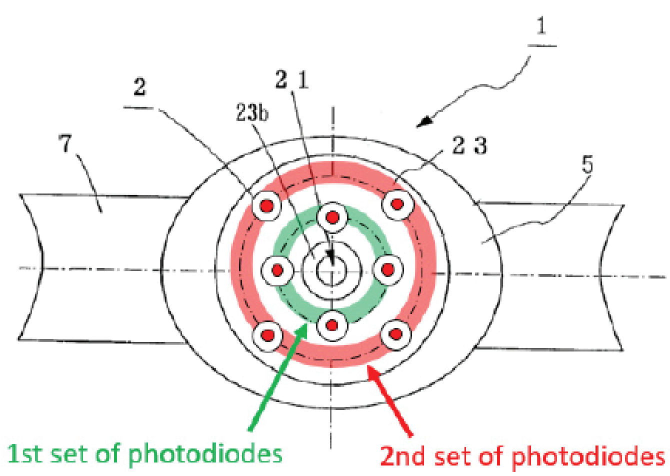
Patent Owner does not dispute these contentions regarding what Mendelson-2003 discloses, and we agree with Petitioner. Mendelson-2003 teaches an experimental sensor in which "six PDs [(photodetectors)] were positioned in a close inner-ring configuration . . . [and a] second set of six PDs [were] spaced equally along an outer-ring." Ex. 1024, 3017, Fig. 1 (depicting a prototype sensor with a near ring of photodetectors and a far ring of photodetectors). Based on experiments using the dual-ring sensor, as compared to sensors using only a near ring or only a far ring, Mendelson-2003 states that "considerabl[y] stronger PPGs [photoplethysmographic signals] could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity." *Id.* at 3019, Fig. 3. Mendelson-2003 also states that, "by combining both PD sets to simulate a single large PD area, it is possible to further reduce the driving currents of the LEDs without compromising the amplitude or quality of the detected PPGs." *Id.* at 3019, Fig. 4. Finally, Mendelson-2003 teaches that estimated battery life for the dual-ring sensor, as compared to sensors using only a near ring or only a far ring, "could be extended considerably." *Id.* at 3019, Table 1 (battery life of 52.5 days for the dual-ring sensor, compared to 45.8 and 20.3 days for the near ring or far ring sensors, respectively).

<u>Petitioner's Disputed Contentions</u>

In view of these teachings, Petitioner contends that a person of ordinary skill in the art would have found it obvious to modify Aizawa to

include an additional ring of detectors, as taught by Mendelson-2003, (i.e., a "second set") to "advance[e] Aizawa's goal of improving detection efficiency through increased power savings." Pet. 20–21 (citing, e.g., Ex. 1003 ¶ 69), 41–43 (citing, e.g., Ex. 1003 ¶¶ 97–100), 48–50 (citing, e.g., Ex. 1003 ¶¶ 107–109). According to Petitioner, "by using Mendelson-2003's power-saving (and thus efficiency-enhancing) PD configuration, the power consumption of a wrist-based pulse sensing device as in Aizawa can be reduced through use of a less bright and, hence, lower power-consuming LED." *Id.* at 23 (citing, e.g., Ex. 1003 ¶ 72).

Petitioner provides "[a] n example implementation of adding an additional ring of detectors to Aizawa, as per Mendelson-2003," which is reproduced below.



Pet. 24 (citing, e.g., Ex. 1003 ¶ 73). Petitioner's modified and annotated figure depicts Aizawa's sensor with Aizawa's first set of photodiodes (depicted as connected by a green ring) and modified to include a second set of photodiodes as taught by Mendelson-2003 (depicted as connected by a red ring). Pet. 23–24, 42–43, 49–50. Petitioner contends this would have been the use of a known solution to improve similar systems in the same

way, which "would have led to predictable [results] without significantly altering or hindering the functions performed by Aizawa's sensor," especially where Aizawa itself discloses adding extra detectors to improve light collection efficiency. *Id.* at 24–25 (citing, e.g., Ex. 1003 ¶ 74).

<u>Patent Owner's Arguments</u>

Patent Owner's arguments address limitations [c]–[e] and [g]–[i] together. *See* PO Resp. 19–21, 54–66. As such, Patent Owner's arguments, the parties' Reply and Sur-reply briefing, and our analyses, are presented below in connection with limitations [e] and [h]. *See infra* § II.D.5.iv.

*iv. "[e] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue;"
and
"[h] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue"*

<u>Petitioner's Undisputed Contentions</u>

Petitioner contends that a signal stream is sent from Aizawa's set of photodetectors 22 to drive detection circuit 24, which amplifies the outputs of the photodetectors. Pet. 18–19 (citing, e.g., Ex. 1006 ¶ 23; Ex. 1003 ¶ 67).

Patent Owner does not dispute this contention, and we agree with Petitioner. Aizawa discloses that "drive detection circuit 24 [is] for detecting a pulse wave by amplifying the outputs of the photodetectors 22." Ex. 1006 ¶ 23.

Petitioner additionally contends that Mendelson-2003 teaches that each set of photodiodes, i.e., its near ring and far ring, are wired in parallel, thereby providing a distinct signal stream for each ring. Pet. 21, 44–45 (citing, e.g., Ex. 1024, 3017).

Patent Owner does not dispute this contention regarding what Mendelson-2003 discloses, and we agree with Petitioner. Mendelson-2003 teaches that "[e]ach cluster of six PDs were wired in parallel and connected through a central hub to the common summing input of a current-to-voltage converter." Ex. 1024, 3017.

Petitioner's Disputed Contentions

In view of these teachings, Petitioner contends that a person of ordinary skill in the art "would have recognized and/or found it obvious that the first set of photodiodes [in the modified system of Aizawa and Mendelson-2003, *see supra* § II.D.5.iii] are connected to one another in parallel to provide a first signal stream in the manner claimed," and the photodiodes in the second/outer ring (i.e., second set of photodiodes) "are connected to one another in parallel to provide a second signal stream," as taught by Mendelson-2003. Pet. 44–45, 50 (citing, e.g., Ex. 1003 ¶¶ 103–110), 21–22 (citing, e.g., Ex. 1003 ¶ 71). Petitioner contends this "would have led to predictable results without significantly altering or hindering the functions performed by Aizawa's sensor." *Id.* at 24–25 (citing, e.g., Ex. 1003 ¶ 75).

According to Petitioner, this arrangement would have provided known benefits. Pet. 44–48. For example, Petitioner contends that a person of ordinary skill in the art "would have known that connecting multiple photodiodes together in parallel allows the current generated by the multiple

photodiodes in [each] set/ring to be added to one another, thereby resulting in a larger total current akin to what would be generated from a single, large detector." *Id.* at 44. According to Petitioner, this was "a routine and conventional design choice." *Id.* at 45. Further, "monitoring each signal stream (from each ring of detectors) separately allows the system to determine when the sensor device is so severely located that its position should be adjusted," and can help detect motion artifacts. *Id.* at 45–46 (citing Ex. 1003 ¶ 104).

Petitioner also argues that a person of skill in the art would have known that "the photodiodes in the far ring (i.e., second set of photodiodes) would receive reflected light having a lower intensity than that received by the photodiodes in the near ring (i.e., first set of photodiodes) and would have been motivated and found it obvious to account for this discrepancy," e.g., by "keep[ing] each ring separately wired and connected to its own amplifier . . . to thereby keep the magnitude of the current signals provided by each ring approximately the same before being combined and transmitted to the arithmetic circuit 3." *Id.* at 46–48 (citing Ex. 1003 ¶¶ 105–106); *id.* at 50 (citing Ex. 1003 ¶ 110).

<u>Patent Owner's Arguments</u>

Patent Owner disputes Petitioner's contentions that it would have been obvious (1) to modify Aizawa to include a second set of at least four photodiodes, and (2) to wire the photodiodes of the first set in parallel to provide a first signal stream and to wire the photodiodes of the second set in parallel to provide a second signal stream. PO Resp. 54–66; Sur-reply 23–29.

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First, Patent Owner argues this proposed modification changes Aizawa's principle of operation. Specifically, Patent Owner claims that "Aizawa's approach monitors different individual detector signals and calculates pulse rate based on each individual photodetector signal" and, in contrast to the proposed modification, "does not measure aggregated signals from detectors connected in parallel." PO Resp. 56 (citing Ex. 1006 ¶¶ 7, 19, 23, 27–29, 32, 36; Ex. 2004 ¶ 102; Ex. 2026, 76:13–22, 79:22–80:3). According to Patent Owner, the proposed modification "eliminates Aizawa's ***core feature***—the ability to monitor pulse using the output of each ***individual*** detector, which Aizawa indicates avoids displacement problems." *Id.* at 57–58 (citing, e.g., Ex. 2004 ¶¶ 104–105).

Second, Patent Owner argues this proposed modification would have resulted in increased power consumption. *Id.* at 58. According to Patent Owner, Mendelson-2003 states that its power savings is caused by "increasing the ***number of detectors*** and thus the detector area, not the two-ring structure." *Id.* at 58–59 (citing Ex. 1024, 3017; Ex. 2004 ¶ 106). Moreover, Patent Owner argues that Aizawa already discloses a way to improve detection efficiency—by including eight detectors in a single ring. *Id.* at 59 (citing Ex. 1006 ¶ 32, Fig. 4A; Ex. 2004 ¶ 107). In light of this teaching, Patent Owner argues that adding a second ring is unfounded and unnecessary, especially where the second ring of detectors "would receive substantially lower light intensity requiring greater power consumption to utilize than additional detectors added to the 'inner' ring." *Id.* at 59–61 (citing, e.g., Ex. 2004 ¶¶ 108–109; Ex. 2026, 55:7–17, 56:6–16, 59:14–60:7, 100:6–101,6, 102:5–17, 112:3–16). "Petitioner never explains why, given these straightforward options to increase signal strength, a [person of

ordinary skill in the art] would instead add an entire new circle of detectors farther from the emitter." *Id.* at 61.

Third, Patent Owner argues that Mendelson-2003 provides only an experimental detector configuration, which would fail to provide the alleged benefits. Specifically, Patent Owner argues that Mendelson-2003 "uses its particular configuration for specific experiments comparing light intensity and LED drive currents for detectors arranged different distances from central emitters," and "teaches no benefits for this arrangement in practice." *Id.* at 62–63 (citing Ex. 1024, 3019; Ex. 2004 ¶¶ 111–112). To the contrary, Patent Owner alleges that Mendelson-2003 actually prefers a single detector ring that outputs a single signal stream: "Mendelson 2003 explains it 'combin[ed] both PD sets to simulate ***a single*** large PD area,' and notes 'battery longevity could be extended considerably by employing ***a*** wide annular PD,' which has a single signal stream—not two different signal streams from two different parallel-connected rings." *Id.* at 62 (citing, e.g., Ex. 2026, 87:8–88:1, 91:15–92:7).[5] Thus, according to Patent Owner, even if a skilled artisan would have added a second ring of detectors to Aizawa,

[5] Patent Owner also criticizes the Petition's discussion of another reference, Mendelson '799 (Ex. 1025), which is not included in Petitioner's identification of the asserted ground of unpatentability. PO Resp. 62–64; Sur-reply 28–29. We discern no error in Petitioner's identification of Mendelson '799. The nature of Petitioner's reliance on Mendelson '799 in support of this ground is explained clearly in the Petition, even if Mendelson '799 is not listed as an additional reference in the identification of the ground. Thus, the Petition complies with 35 U.S.C. § 312(a)(3) (stating an IPR petition must "identif[y], in writing and with particularity . . . the grounds on which the challenge to each claim is based, and the evidence that supports the grounds for the challenge").

they "would not have kept the first and second ring of detectors ***separate*** or separately amplified the aggregated signals"; instead, they would have "combin[ed] both PD sets to simulate ***a single*** large PD area," where "battery longevity could be extended considerably by employing ***a*** wide annular PD." *Id.* at 65 (quoting Ex. 1024, 3019; citing Ex. 2004 ¶ 116).

Finally, Patent Owner argues that the proposed combination "introduces signal processing problems requiring a ***further*** redesign for Aizawa's sensor" to include a second amplifier to account for signals of different strengths between the near and far rings. *Id.* at 64–65 (citing Ex. 2004 ¶ 115). Patent Owner alleges this demonstrates that a skilled artisan would not have added a second ring of detectors, as proposed, but instead would have increased the number of detectors in Aizawa's single ring. *Id.* at 65.

Petitioner's Reply

Petitioner replies that Patent Owner mischaracterizes Aizawa's principle of operation. Pet. Reply 31–33. Specifically, Petitioner contends that Aizawa's detector ring is connected in parallel, or at least that a person of ordinary skill in the art would have recognized that parallel connection would have been a known implementation detail, which allows a signal to be detected even if one of the multiple sensors is displaced on the user. *Id.* at 32 (citing Ex. 1003 ¶¶ 102–103; Ex. 1060 ¶ 62; Ex. 2026, 72:3–9). Moreover, Petitioner argues that Aizawa lacks any disclosure of individually monitoring signals from each photodetector. *Id.* at 33.

Petitioner reiterates its position that adding a second ring would collect a bigger portion of backscattered light, and would motivate the proposed combination. *Id.* at 33 (citing, e.g., Ex. 1060 ¶¶ 64–66). Petitioner

also disputes that such a modification would increase power, noting that it is the emitters, not the detectors, that consume most power in the system. *Id.* at 34 (citing, e.g., Ex. 1060 ¶ 67). Moreover, Petitioner contends that by widening the detection area with a second ring, the system would capture additional light which would allow a lower brightness, and lower power, emitter to be used. *Id.* at 24–35.

Petitioner disputes Patent Owner's characterization of Mendelson-2003 as purely experimental, and alleges that Mendelson-2003 makes clear that employing two rings outputting two signal streams is equivalent to employing a wider single ring of detectors, and provides associated benefits. *Id.* at 35–37 (citing, e.g., Ex. 1060 ¶¶ 70–71).

Patent Owner's Sur-reply

Patent Owner reiterates its position that Aizawa concerns individual monitoring, which Patent Owner alleges is a "key feature of Aizawa's sensor," in order to avoid problems associated with sensor displacement. Sur-reply 23–25. Patent Owner also reiterates its positions that the proposed modified sensor would consume more power, and that Aizawa's disclosed embodiment with eight detectors in a single ring would have been preferred. *Id.* at 25–29.

Analysis

We have considered the parties' arguments and cited evidence, and we are persuaded by Petitioner's contentions. As discussed above, Aizawa discloses a sensor with a first set of four phototransistors 22 as claimed, which are disposed in a single ring around central emitter 21. Ex. 1006 ¶ 23, Figs. 1(a)–1(b). Mendelson-2003 teaches a sensor with a dual-ring

configuration, where a first inner ring includes six photodetectors, and a second outer ring includes an additional six photodetectors. Ex. 1024, 3017, Fig. 1. Mendelson-2003 also states that by using this dual-ring configuration to simulate a wide photodetector area, stronger signals could be obtained, drive currents could be reduced, and battery life could be extended. *Id.* at 3019, Figs. 3, 4.

In light of these explicit teachings, we are persuaded by Petitioner's contention that a person of ordinary skill in the art would have found it obvious to include a second set of detectors in Aizawa's sensor, as taught by Mendelson-2003, to realize the benefits taught by Mendelson-2003, i.e., stronger signals with reduced power consumption. Pet. 21–23, 44–46. We credit Dr. Kenny's testimony that this would have been the use of a known solution—a sensor with dual detector rings as taught by Mendelson-2003—to improve similar systems—Aizawa's sensor with one detector ring—in the same way, which "would have led to predictable results without significantly altering or hindering the functions performed by Aizawa's sensor," especially where Aizawa itself discloses adding extra detectors to improve light collection efficiency. Ex. 1003 ¶ 75.

We also credit Dr. Kenny's testimony that, as taught by Mendelson-2003, it would have been obvious to connect the photodetectors of each set in parallel to provide first and second signal streams, respectively, and that this would have led to predictable results. Ex. 1003 ¶ 74 (predictable), 93–103 (first set), 110 (second set). Indeed, the two rings taught by Mendelson-2003 are disclosed as being "wired in parallel and connected through a central hub to the common summing input of a current-to-voltage converter." Ex. 1024, 3017. Dr. Kenny explains numerous advantages

associated the parallel connections taught by Mendelson-2003, such as monitoring for displacement, accounting for motion artifacts, and compensating for the relative decrease in light that reaches the outer ring, which cannot be achieved with a single signal stream. Ex. 1003 ¶¶ 101–106.

We have considered Patent Owner's arguments but find them to be misplaced. First, we do not agree that Aizawa discloses the ability to individually monitor individual detectors as a "key feature" (PO Resp. 55; Sur-reply 24) of its sensor. We discern no persuasive support for this position in Aizawa. Aizawa does not discuss individual monitoring at all, at least not clearly, and does not discuss individual monitoring as a solution to sensor displacement. Rather, Aizawa explains that its sensor includes four photodetectors 22 and that "reflected light is detected by the plurality of photodetectors 22." Ex. 1006 ¶¶ 23, 27. Aizawa also explains that its sensor includes a "drive detection circuit 24 for detecting a pulse wave by amplifying the outputs of the photodetectors 22." *Id.* ¶ 23. These disclosures indicate that Aizawa does not monitor each photodetector 22 individually to ascertain the pulse wave but, rather, utilizes "the outputs" of *all* of the photodetectors together.

This understanding is consistent with Aizawa's disclosure of sensor displacement. As Patent Owner correctly notes, Aizawa recognizes a problem with sensor displacement, in which "no output signal can be obtained" if the sensor's detectors are placed away from an artery. *Id.* ¶ 7. Aizawa solves this problem by avoiding a "linear[]" detector arrangement, such that "[e]ven when the attachment position of the sensor is dislocated, a pulse wave can be detected accurately." *Id.* ¶ 9. Indeed, Aizawa is clear that, in its preferred embodiment, it is the disposition of photodetectors 22 in

"a circle concentric to the light emitting diode 21" that enables accurate pulse detection even when the sensor is dislocated. *Id.* ¶ 27. Aizawa does not discuss individual monitoring in relation to sensor dislocation.

We have examined Patent Owner's alleged support for the importance of individual monitoring and find it lacking. *See, e.g.*, PO Resp. 56 (citing Ex. 1006 ¶¶ 7, 19, 23, 27–29, 32, 36; Ex. 2004 ¶ 102; Ex. 2026, 76:13–22, 79:22–80:3). Patent Owner identifies Figure 3, which depicts a "diagram of a pulse wave which is the output of *a photodetector*." Ex. 1006 ¶¶ 19 (emphasis added), 28 ("the above photodetector 22"). Patent Owner seems to place importance on the use of the article "a" or "the" photodetector, in the singular. PO Resp. 56; Sur-reply 24. However, we discern no significance in the singular use. In discussing this Figure, Aizawa does not discuss monitoring an individual photodetector, or describe that as a "key feature"; instead, Aizawa explains that drive detection circuit 24 amplifies the detected pulse wave and transmits it to arithmetic circuit 3, which compares it to a threshold value to calculate a pulse rate. Ex. 1006 ¶ 28. We discern that this discussion of how the circuits process a signal from "a" (or "the") photodetector is merely exemplary of the process; Patent Owner has not pointed to any persuasive support for its position that this somehow indicates a "key feature" of Aizawa is individual monitoring. As noted above, Aizawa plainly discloses that it is the signals from *the plurality* of photodetectors that is used to determine a pulse wave. *Id.* ¶¶ 23, 27. Nothing in Figure 3 or paragraph 28 clearly contradicts that disclosure.

We have considered the cited testimony of Dr. Madisetti, which Patent Owner relies upon as support for its position, but we find it lacking as well. Dr. Madisetti's testimony includes the same citations presented by

Patent Owner, none of which demonstrates individual monitoring. Ex. 2004 ¶ 102. Thus, we determine this testimony to be conclusory and entitled to little weight.

We do recognize, as did Dr. Kenny during his deposition, that Aizawa does not provide extensive discussion of the algorithms through which Aizawa determines a pulse wave. *See, e.g.*, Ex. 2026, 80:8–18 ("It doesn't describe the algorithm in detail. It just says amplifies the signals from the detectors and then performs whatever function takes place inside the arithmetic circuit. . . . It's left for one of ordinary skill in the art to process the waveforms."). Nonetheless, we decline Patent Owner's invitation to import into Aizawa's disclosure a "key feature" of individual monitoring that is not identified by Aizawa with any reasonable clarity. Again, as noted above, Dr. Madisetti provides no further support for the conclusory position advanced by Patent Owner.

By contrast, we credit Dr. Kenny's testimony, which is consistent with Aizawa's express disclosure of detecting a pulse wave from "the plurality of photodetectors" (Ex. 1006 ¶ 27), that:

> connecting multiple photodetectors together in parallel allows the current generated by the multiple photodetectors to be added to one another, which would subsequently ensure that even if one of multiple sensors connected in parallel were to be displaced so as to receive no signal, the fact that all the sensors are connected in parallel such that their signals are summed means that a signal will still be detected, in accordance with Aizawa's objective.

Ex. 1060 ¶ 62. Moreover, we agree with Dr. Kenny that "there is no disclosure anywhere in Aizawa to suggest that it is even capable of somehow monitoring the signals of each photodetector, and there is certainly no need to do so if its sensors are connected in parallel." *Id.* Thus,

considering the express disclosure of Aizawa and the competing testimony of the parties' experts, we credit that of Dr. Kenny.

Patent Owner's second argument—that the proposed modification would have resulted in increased power consumption—is plainly contradicted by Mendelson-2003's disclosure. Table 1 of Mendelson-2003 is reproduced below.

Table 1. Comparison of estimated battery life for different PD configurations. Values based on forehead measurements for a typical 220mAhr coin size battery.

PD CONFIGURATION	BATTERY LIFE [Days]
Near	45.8
Far	20.3
Near+Far	52.5

Table 1 includes three rows, each associating a different photodetector configuration with an estimated battery life. Ex. 1024, 3019. The table indicates that a configuration consisting of only a near ring of photodetectors results in 45.8 days of battery life; a configuration consisting of only a far ring of photodetectors results in 20.3 days of battery life; and a configuration consisting of both a near ring and a far ring of photodetectors results in 52.5 days of battery life. *Id.* In describing this table, Mendelson-2003 states, "the considerable differences in the estimated power consumptions clearly points out the practical advantage gained by using a reflection sensor comprising a large ring-shaped PD area to perform SpO_2 measurements," which in this case, was realized by the combination of a near and far ring of detectors, akin to the modification proposed by Petitioner. *Id.* Thus, we do not agree with Patent Owner's argument that power consumption would increase if a second ring of detectors were added to Aizawa's sensor; Mendelson-2003 plainly suggests the opposite and supports Petitioner's

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contention that the proposed modification would result in a power savings over a single ring.

We also do not agree with the argument that a person of ordinary skill in the art would not make the proposed modification because Aizawa already discloses a way to improve detection efficiency, e.g., by including more detectors in a single ring. PO Resp. 59 (citing Ex. 1006 ¶ 32, Fig. 4A; Ex. 2004 ¶ 107). Aizawa explains that the photodetector arrangement of its single-ring preferred embodiment "is not limited" and suggests, "[f]or example," that "the number of photodetectors 22 may be increased." Ex. 1006 ¶ 32. Aizawa does not limit the increase in photodetectors to being included in only the existing single ring of detectors, i.e., the first set. Nothing in this disclosure teaches against adding a second set, as proposed by Petitioner for the well-supported reasons identified in Mendelson-2003 and further discussed by Dr. Kenny.

Patent Owner's third argument—that Mendelson-2003 is experimental and would not provide the alleged benefits—likewise fails. Patent Owner's suggestion that Mendelson-2003 teaches using a single large, wide detector ring that outputs a single signal stream is unfounded. The analysis provided in Mendelson-2003 explicitly compares a dual-ring arrangement to both a single near ring and a single far ring. *See, e.g.*, Ex. 1024, Figs. 3, 4, Table 1 (all comparing near, far, and near + far arrangements). Mendelson-2003 explains that the dual-ring arrangement "simulate[s] a single large PD area" and realizes benefits in LED power requirements. *Id.* at 3019. That Mendelson-2003 *simulates* a single ring by using two discrete rings demonstrates the fallacy of Patent Owner's argument.

Finally, we disagree with Patent Owner's argument that a person of ordinary skill in the art would not have made the proposed combination because it "introduces signal processing problems requiring a ***further*** redesign for Aizawa's sensor" to include a second amplifier to account for signals of different strengths between the near and far rings. PO Resp. 64–65. A person of ordinary skill in the art must be presumed to understand something about the art beyond what is disclosed in the references. *See In re Jacoby*, 309 F.2d 513, 516 (CCPA 1962). After all, "[a] person of ordinary skill is also a person of ordinary creativity, not an automaton." *KSR*, 550 U.S. at 421. Neither Patent Owner nor Dr. Madisetti assert that adding a second amplifier would be beyond the level of skill in the art or would introduce any specific problems, beyond its mere addition. We credit Dr. Kenny's testimony that a person of ordinary skill would have recognized that, in order to account for the disparate currents generated by the two rings, the rings would be separately wired with separate amplifiers (Ex. 1003 ¶ 106) and that this would have been a routine and conventional design choice, within the level of ordinary skill in the art (*id.* ¶ 103).

For the foregoing reasons, we are persuaded by Petitioner's contentions.

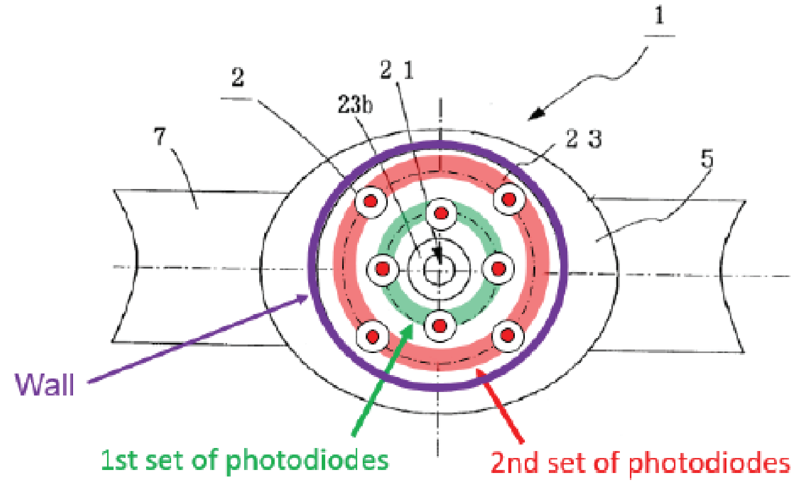
v. "[i] at least one of the first signal stream or the second signal stream includes information usable to determine a physiological parameter of a wearer of the noninvasive physiological parameter measurement device;"

The cited evidence supports Petitioner's undisputed contention that Aizawa discloses a signal stream usable to determine at least pulse rate. Pet. 43–48, 51. Petitioner contends that "Aizawa teaches that a 'drive detection circuit 24' is used for 'amplifying the outputs [*i.e.*, signal stream]

of the photodetectors' and transmitting the amplified data to the arithmetic circuit 3, which computes the pulse rate, which is a physiological parameter." Pet. 51 (quoting Ex. 1006 ¶¶ 23, 28) (citing Ex. 1003 ¶ 111 ("Because the signal stream from Aizawa's detectors can be used to calculate pulse rate, it represents information usable to determine a physiological parameter of a wearer of the noninvasive physiological parameter measurement device.")).

vi. "[j] a wall extending from the surface and configured to surround at least the first and second sets of photodiodes; and"

The cited evidence also supports Petitioner's undisputed contention that Aizawa discloses a wall that surrounds the photodiodes, including the second set as suggested by the combined teachings of Aizawa and Mendelson-2003. Pet. 51–52; *see, e.g.*, Ex. 1006 ¶ 23 ("holder 23 for storing" LED 21 and detectors 22), Fig. 1(b) (depicting periphery of holder 23 surrounding the sensor components, including detectors 22, which are positioned on a surface); Ex. 1003 ¶¶ 100–102, 112. Petitioner contends that "[t]he outer periphery of Aizawa's holder 23 provides a circular wall (purple) that surrounds at least the first and second sets of photodiodes," and provides an annotated version of Aizawa's Figure 1(a), which is reproduced below.



Petitioner's modified and annotated Figure 1(a) of Aizawa depicts a wall (purple) surrounding both the first set of photodiodes and the second set of photodiodes. Pet. 52. Petitioner likewise contends that the identified wall extends from the surface of the substrate. *Id.* These undisputed contentions are sufficiently supported.

vii. "[k] a cover arranged to cover at least a portion of the surface of the substrate, wherein the cover comprises a protrusion that extends over all of the photodiodes of the first and second sets of photodiodes arranged on the surface, and wherein the cover is further configured to cover the wall."

Petitioner's Undisputed Contentions

Petitioner contends that Aizawa "teaches a light permeable cover in the form of an acrylic transparent plate 6 . . . that is mounted at the detection face 23a" of the sensor, i.e., above Aizawa's photodetectors, to provide "improved adhesion between the detector and the wrist to 'further improv[e] the detection efficiency of a pulse wave.'" Pet. 10–11 (citing Ex. 1006 ¶ 30, Fig. 1(b); Ex. 1003 ¶¶ 52–53). Patent Owner does not dispute this contention, and we agree with Petitioner. Aizawa discloses that "acrylic

transparent plate 6 is provided on the detection face 23a of the holder 23 to improve adhesion to the wrist 10." Ex. 1006 ¶ 34, Fig. 1(b) (depicting transparent plate 6 between sensor 2 and wrist 10).

Petitioner also contends that Ohsaki teaches a wrist-worn sensor that includes a "translucent board" having a convex surface that contacts the user's skin to prevent slippage of the sensor. Pet. 14, 26–27 (citing Ex. 1014 ¶¶ 9–10). Patent Owner does not dispute this contention, and we agree with Petitioner. Ohsaki discloses that sensor 1 includes detecting element 2 and sensor body 3, and is "worn on the back side of the user's wrist 4." Ex. 1014 ¶ 16. Ohsaki discloses that detecting element 2 includes package 5 and "translucent board 8[,which] is a glass board which is transparent to light, and [is] attached to the opening of the package 5. A convex surface is formed on the top of the translucent board 8." *Id.* ¶ 17. As seen in Ohsaki's Figure 2, translucent board 8 has a single protruding convex surface, which is placed between a user's tissue and a light receiving element (e.g., photodetector) 7 when the sensor is worn. *Id.* at Fig. 2. As also seen in Figure 2, the board 8 is operably connected to the walls of sensor package 5. *Id.* ¶ 17 ("The translucent board 8 is . . . attached to the opening of the package 5."), Fig. 2.

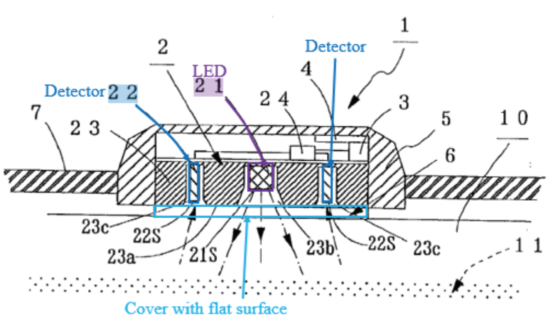
<u>Petitioner's Disputed Contentions</u>

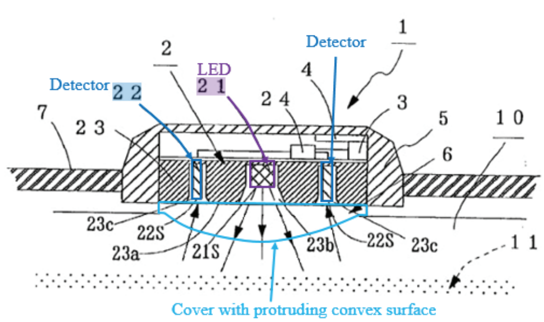
Petitioner further contends that a person of ordinary skill in the art "would have found it obvious to modify Aizawa's sensor to include a cover having a protruding convex surface," so as to (1) improve adhesion between the user's wrist and the sensor's surface, (2) improve detection efficiency, and (3) protect the elements within sensor housing. Pet. 25–29 (citing, e.g., Ex. 1003 ¶¶ 76–80; Ex. 1014 ¶ 25). Petitioner contends that Ohsaki's

convex surface is in "intimate contact" with the user's skin, which prevents slippage of the sensor and increases signal strength because "variation of the amount of the reflected light . . . that reaches the light receiving element 7 is suppressed" and because "the pulse wave can be detected without being affected by the movement of the user's wrist 4," as compared to a sensor with a flat surface. *Id.* at 26–28 (citing, e.g., Ex. 1003 ¶ 78; quoting Ex. 1014 ¶¶ 15, 17, 25, Figs. 1, 2, 4A, 4B). Accordingly, Petitioner contends that a person of ordinary skill in the art would have modified Aizawa's sensor to include a cover with a protruding convex surface, as taught by Ohsaki, that is "between a subject's wrist and a surface of the sensor." Pet. 25–29 (citing, e.g., Ex. 1003 ¶¶ 76–80).

Petitioner contends this modification would have been "nothing more than the use of a known technique to improve similar devices in the same way," i.e., when Ohsaki's sensor is worn "'the convex surface of the translucent board . . . is in intimate contact with the . . . user's skin'; this contact . . . prevents slippage, which increases the strength of the signals obtainable by Ohsaki's sensor." Pet. 26–29 (citing Ex. 1003 ¶¶ 77–80).

To illustrate its proposed modification, Petitioner includes two annotated versions of Aizawa's Figure 1(b), both of which are reproduced below. Pet. 25–29 (citing Ex. 1003 ¶¶ 76–80).





Petitioner's annotated figure on the left depicts Aizawa's sensor, modified to include a flat "acrylic transparent plate" (illustrated with blue outline); Petitioner's annotated figure on the right depicts Aizawa's sensor, modified to include a "cover with protruding convex surface" (illustrated with blue outline). Pet. 29.

Patent Owner's Arguments

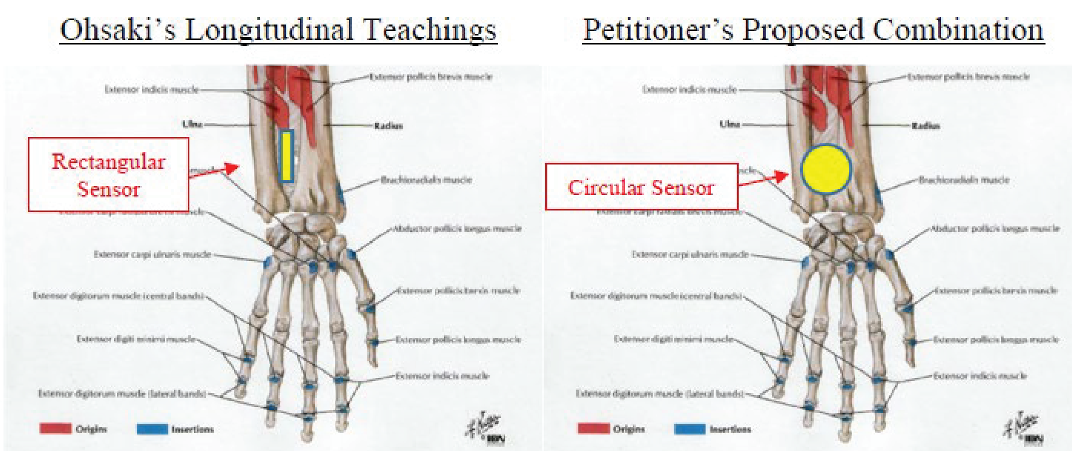
Patent Owner argues that a person of ordinary skill in the art would not have been motivated to modify Aizawa's sensor to include Ohsaki's convex cover. PO Resp. 11–18, 22–54;[6] Sur-reply 3–23.

First, Patent Owner argues "Ohsaki's rectangular board would be incompatible with Aizawa's circular sensor arrangement" and that the proposed modification "eliminates the longitudinal shape that Ohsaki specifically identifies as important for the benefit of reducing slipping." PO Resp. 23–25 (emphases omitted). This argument is premised on Patent Owner's contention that Ohsaki's convex cover must be rectangular, with the cover's long direction aligned with the length of the user's forearm, to

[6] As an initial matter, Patent Owner observes that Petitioner "[r]eli[es] on a non-ground reference, Inokawa" (Ex. 1008), as providing the rationale for the proposed modification of Aizawa in view of Ohsaki, and as providing implementation details of the combination. PO Resp. 22–23 (citing Pet. 30–31); *id.* at 45–46, 51–52. We discern no error in Petitioner's identification of Inokawa. The nature of Petitioner's reliance on Inokawa in support of this ground is explained clearly in the Petition, even if Inokawa is not listed as an additional reference in the identification of the ground. Thus, the Petition complies with 35 U.S.C. § 312(a)(3) (stating an IPR petition must "identif[y], in writing and with particularity . . . the grounds on which the challenge to each claim is based, and the evidence that supports the grounds for the challenge").

avoid interacting with bones in the wrist and forearm. *Id.* at 25–30 (citing, e.g., Ex. 2004 ¶¶ 55–62; Ex. 1014 ¶¶ 6, 19, 23–25); *see also* Sur-reply 3–11. According to Patent Owner, Ohsaki teaches that "aligning the sensor's longitudinal direction with the circumferential direction of the user's arm undesirably results in 'a tendency [for Ohsaki's sensor] to slip off.'" PO Resp. 26 (emphasis omitted) (alteration in original) (citing Ex. 1014 ¶ 19).

Thus, Patent Owner contends that Petitioner's proposed modification would "chang[e] Ohsaki's longitudinal detecting element and rectangular board into a circular shape," which "would eliminate the advantages discussed above" because it "cannot be placed in any longitudinal direction and thus cannot coincide with the longitudinal direction of the user's wrist." *Id.* at 27 (emphases omitted) (citing Ex. 2004 ¶¶ 57–58). Patent Owner presents annotated Figures depicting what it contends is Ohsaki's disclosed sensor placement as compared to that of the proposed modification, reproduced below.



Patent Owner's annotated Figure on the left depicts a rectangular sensor placed between a user's radius and ulna, while Patent Owner's annotated Figure on the right depicts a circular sensor placed across a user's radius and

ulna. Based on these annotations, Patent Owner argues that the proposed "circular shape would press on the user's arm in all directions and thus cannot avoid undesirable interaction with the user's bone structure," such that a skilled artisan "would have understood that any such change would eliminate any benefit of Ohsaki's board for preventing slipping." PO Resp. 28–30 (citing, e.g., Ex. 2004 ¶¶ 55–62).[7]

Patent Owner additionally argues that changing Aizawa's circular sensor to accommodate Ohsaki's longitudinal structure "would redirect light away from some detectors and towards others" and would "disrupt Aizawa's sensor's circular symmetry." *Id.* at 30–32. This argument is premised on Patent Owner's contention that Ohsaki's convex cover must be rectangular. *Id.* at 30 (citing Ex. 2004 ¶¶ 63–64). According to Patent Owner, "placing Ohsaki's rectangular board onto Aizawa's circular sensor would result in undesirable asymmetrical pressure and inconsistent contact at the peripheral edge where Aizawa's detectors are located," which would "create air gaps over some of Aizawa's peripherally arrayed detectors, but not others, which could result in degraded optical signals." *Id.* at 31–32 (emphasis omitted) (citing Ex. 2004 ¶¶ 65–66). Thus, Patent Owner argues that a person of ordinary skill in the art "would not have been motivated to use Ohsaki's rectangular board with Aizawa's circular sensor." *Id.* at 32 (citing Ex. 2004 ¶¶ 65–66).

[7] Patent Owner further argues, "[t]o the extent Petitioner contends a [person of ordinary skill in the art] would use Ohsaki's rectangular board on Aizawa's circular sensor . . . that argument is unsupported and incorrect." PO Resp. 30. We do not read the Petition as making such a contention. We understand Petitioner to propose, in essence, changing Aizawa's circular *flat* cover into a circular *convex* cover. *See, e.g.*, Pet. 28–29.

Second, Patent Owner argues that Ohsaki requires its sensor be placed on the back of the user's wrist to achieve any benefits, but that such a location would have been unsuitable for Aizawa's sensor. PO Resp. 33. Specifically, Patent Owner argues that Aizawa's sensor must be worn on the palm side of the wrist, close to radial and ulnar arteries, which is the side opposite from where Ohsaki's sensor is worn. *Id.* at 33–42 (citing, e.g., Ex. 1006 ¶¶ 2, 7, 9, 26, 27, 36; Ex. 2004 ¶¶ 68–81). According to Patent Owner, Ohsaki teaches that the sensor's convex surface has a tendency to slip when placed on the palm side of the wrist, i.e., in the location taught by Aizawa. *Id.* at 39–42 (citing, e.g., Ex. 1014 ¶¶ 19, 23–24; Ex. 2004 ¶¶ 75–81). Thus, Patent Owner argues that a person of ordinary skill in the art "would not have been motivated to use Ohsaki's longitudinal board—designed to be worn on the back side of a user's wrist—with Aizawa's palm-side sensor." *Id.* at 42 (emphases omitted). Similarly, Patent Owner argues that Aizawa teaches away from the proposed modification because Aizawa teaches that its flat acrylic plate improves adhesion on the palm side of the wrist, while Ohsaki teaches that its convex board "has a tendency to slip" on the palm side of the wrist. *Id.* at 33–39 (citing, e.g., Ex. 2004 ¶¶ 67–74).

Third, Patent Owner argues that a person of ordinary skill in the art would not have placed Ohsaki's convex cover over Aizawa's peripheral detectors because the convex cover would condense light toward the center and away from Aizawa's detectors, which would decrease optical signal strength. PO Resp. 45–53 (citing, e.g., Ex. 2004 ¶¶ 86–97). Patent Owner also contends that Petitioner and Dr. Kenny admitted as much in a related proceeding. *Id.* at 46–47 (citing, e.g., Ex. 2019, 45; Ex. 2020, 69–70). Patent Owner also relies on Figure 14B of the '366 patent to support its

position. *Id.* at 47–48 (citing Ex. 1001, 36:3–6, 36:13–15). In light of the foregoing, Patent Owner argues that a person of ordinary skill in the art would have understood that the proposed modification would have decreased signal strength by directing light away from Aizawa's peripheral detectors. *Id.* at 47.

Fourth and finally, Patent Owner argues that a person of ordinary skill in the art "would have understood that Aizawa's flat plate would provide better protection than a convex surface" because it "would be less prone to scratches." *Id.* at 53–54 (emphasis omitted) (citing Ex. 1008 ¶ 106; Ex. 2004 ¶¶ 98–99).

<u>Petitioner's Reply</u>

Concerning Patent Owner's first and second arguments, Petitioner responds that Ohsaki does not disclose the shape of its protrusion, other than its convexity as shown in Figures 1 and 2, nor does Ohsaki require a rectangular shape or placement on the back of the wrist in order to achieve the disclosed benefits. Pet. Reply 8–20 (citing, e.g., Ex. 1060 ¶¶ 7–30). Moreover, Petitioner asserts that "[e]ven if Ohsaki's translucent board 8 were understood to be rectangular, obviousness does not require 'bodily incorporation' of features from one reference into another"; rather, a person of ordinary skill in the art "would have been fully capable of modifying Aizawa to feature a light permeable protruding convex cover to obtain the benefits" taught by Ohsaki. *Id.* at 16 (citing, e.g., Ex. 1060 ¶ 23). Similarly, regarding the location of the sensor, Petitioner asserts,

> [E]ven assuming for the sake of argument that a [person of ordinary skill in the art] would have understood Aizawa's sensor as being limited to placement on the backside of the wrist, and would have understood Ohsaki's sensor's "tendency to slip"

> when arranged on the front side as informing consideration of Ohsaki's teachings with respect to Aizawa, that ***would have further motivated*** the [person of ordinary skill in the art] to implement a light permeable convex cover in Aizawa's sensor, to improve detection efficiency of that sensor when placed on the palm side.

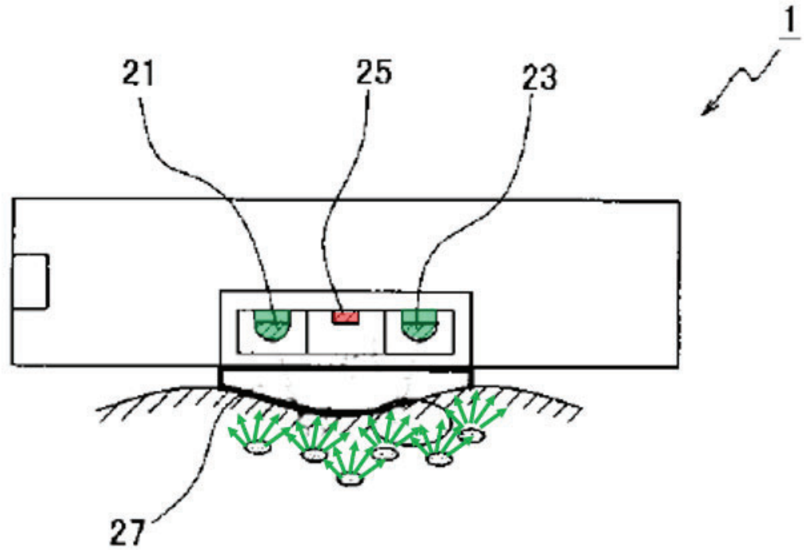
Id. at 18 (citing, e.g., Ex. 1060 ¶ 27). In other words, Ohsaki's disclosure that a convex surface suppresses variation in reflected light would have motivated an artisan to add such a surface to Aizawa to improve detection efficiency of that sensor when placed on the palm side. *Id.* at 18.

Concerning Patent Owner's third argument, Petitioner responds that adding a convex cover to Aizawa's sensor would not decrease signal strength but, instead, "would improve Aizawa's signal-to-noise ratio by causing more light backscattered from tissue to strike Aizawa's photodetectors than would have with a flat cover" because such a cover improves light concentration across the entire lens and does not direct it only towards the center. *Id.* at 20–21 (citing, e.g., Ex. 1060 ¶ 31).

Petitioner asserts that Patent Owner and Dr. Madisetti "ignore[] the well-known principle of reversibility," by which "a ray going from P to S will trace the same route as one from S to P." Pet. Reply 22 (emphasis omitted) (quoting Ex. 1061, 84, 92; Ex. 1062, 101, 110; Ex. 1053, 80:20–82:20). When applied to Aizawa's sensor, Petitioner contends that any condensing benefit achieved by a convex cover would thus direct emitted light toward Aizawa's peripheral detectors. *Id.* at 22–25 (citing, e.g., Ex. 1060 ¶¶ 35–45). Indeed, Petitioner contends this core concept of reversibility is applied in Aizawa. *Id.* at 25 (citing, e.g., Ex. 1006 ¶ 33; Ex. 1060 ¶¶ 41–44).

Petitioner also asserts that Patent Owner and Dr. Madisetti overlook the fact that light rays reflected by body tissue will be scattered and diffuse and will approach the detectors "from various random directions and angles." Pet. Reply 25–30 (citing, e.g., Ex. 1060 ¶¶ 46–59; Ex. 1061, 84 Ex. 1062, 101; Ex. 1063, 52, 86, 90; Ex. 1053, 80:20–82:20). This scattered and diffuse light, according to Petitioner, means that Ohsaki's convex cover cannot "focus[] light to the center" of the sensor device, as Patent Owner argues. *Id.* at 26. Instead, due to the random nature of this scattered light, Petitioner asserts that a person of ordinary skill in the art would have understood that "Ohsaki's convex cover provides a slight refracting effect, such that light rays that may have missed the detection area are instead directed toward that area." *Id.* at 26 (citing, e.g., Ex. 1060 ¶¶ 48–49). Petitioner applies this understanding to Aizawa, and asserts that using a cover with a convex protrusion in Aizawa would "enable backscattered light to be detected within a circular active detection area." *Id.* (citing, e.g., Ex. 1063, 86, 90).

Petitioner relies upon the following illustration of this alleged effect. Pet. Reply 29 (citing Ex. 1060 ¶ 54).



The above illustration depicts backscattered light with Aizawa's sensor reflecting off user tissue in various directions, such that it impinges upon the peripheral detectors from various random angles and directions. *Id.* According to Petitioner, this allows the detector to capture "light rays that otherwise would have missed the active detection area are instead directed toward that area." *Id.* (citing Ex. 1060 ¶ 55).

Petitioner also dismisses Patent Owner's reliance on Figure 14B of the '366 patent because it "is not a representation of light that has been reflected from a tissue measurement site." Pet. Reply 28 (citing, e.g., Ex. 1060 ¶¶ 51–52). According to Petitioner, for example, "[t]he light rays (1420) shown in FIG. 14B are collimated (i.e., parallel to one another), and each light ray's path is perpendicular to the detecting surface." *Id.*

Concerning Patent Owner's fourth argument, Petitioner responds that even if a flat surface might be less prone to scratching, that possible disadvantage would have been weighed against the "known advantages of applying Ohsaki's teachings," and would not negate a motivation to combine. *Id.* at 31 (citing, e.g., Ex. 1060 ¶ 60).

Patent Owner's Sur-reply

Concerning Patent Owner's first and second arguments, Patent Owner reiterates its position that Ohsaki's purported benefits attach only to a sensor with a rectangular convex surface that is located on the back of the wrist, and that "even small changes in sensor orientation or measurement location result in slippage." Sur-reply 1–14, 8.

Concerning Patent Owner's third argument (that the convex cover would condense light toward the center and away from Aizawa's detectors), Patent Owner asserts that Dr. Kenny and Petitioner have not overcome their admissions that a convex lens directs light toward the center. *Id.* at 14–16, 19–21. Patent Owner argues that Petitioner's Reply improperly presents several new arguments, relying on new evidence, as compared with the Petition. *Id.* at 16 (regarding reversibility), 16–19. Moreover, Patent Owner argues that Petitioner's discussion of the principle of reversibility is "irrelevant" because it "assumes conditions that are not present when tissue scatters and absorbs light." *Id.* at 16. The random nature of backscattered light, in Patent Owner's view, "hardly supports Petitioner's argument that light will necessarily travel the same paths regardless of whether the LEDs and detectors are reversed," and is irrelevant to the central issue presented here of "whether changing Aizawa's flat surface to a convex surface results in more light on Aizawa's peripherally located detectors." *Id.* at 17–18.

Patent Owner also asserts that Petitioner mischaracterizes Patent Owner's position, which is not that Ohsaki's cover with a convex protrusion "focuses ***all*** light to a single point" at the center of the sensor as Petitioner characterizes it. Sur-reply 19. Patent Owner's position, rather, is that Petitioner has not shown that a person of ordinary skill in the art "would

have been motivated to change Aizawa's flat surface to a convex surface to improve signal strength." *Id.* In Patent Owner's view, by arguing that the convex cover provides only a "slight refracting effect," Petitioner undermines its contention that providing such a cover would have improved detection efficiency. *Id.* at 19–20 (emphasis omitted).

Patent Owner also argues that Petitioner's contention that a convex cover allows more light collection generally is a new theory not supported by Dr. Kenny's original declaration. *Id.* at 20. Moreover, Patent Owner argues that Petitioner's theory is "unavailing because it fails to consider the greater decrease in light at the detectors due to light redirection to a more central location." *Id.* (emphasis omitted). According to Patent Owner, any light redirected from the sensor's edge could not make up for the loss of signal strength from light redirected away from the detectors and toward the center. *Id.*

Concerning Patent Owner's fourth argument, Patent Owner argues that Petitioner does not dispute Patent Owner's position that a flat cover would be less prone to scratches and offers "***no*** plausible advantages for its asserted combination." *Id.* at 23. Moreover, Patent Owner argues that the risk of scratches undermines Petitioner's argument of adding a convex cover to protect the elements within the sensor housing. *Id.*

<u>Analysis</u>

As noted above, Petitioner provides three rationales to support its contention that a person of ordinary skill in the art would have provided "a light permeable cover with a protruding convex surface," such as that taught by Ohsaki, to Aizawa's sensor: (1) to improve adhesion between the sensor and the user's tissue, (2) to improve detection efficiency, and (3) to protect

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the elements within the sensor housing. Pet. 26–32 (citing, e.g., Ex. 1003 ¶¶ 76–84; Ex. 1014 ¶ 25). As further examined below, we determine all three rationales are supported by the evidence, and further that any single rationale standing alone would have been sufficient to establish a basis for the person of ordinary skill in the art to combine the references as proposed.

Rationales 1 and 2

The evidence of record persuades us that adding a convex cover, such as that taught by Ohsaki, would have improved adhesion between the sensor and the user's skin, which would have increased the signal strength of the sensor. Ohsaki teaches as much:

> [T]he convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin. Thereby *it is prevented that the detecting element 2 slips off* the detecting position of the user's wrist 4. If the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist 4 as shown in Fig. 4B. However, in the case that the translucent board 8 has a convex surface like the present embodiment, the *variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin is suppressed. It is also prevented that noise such as disturbance light from the outside penetrates the translucent board 8*. Therefore the pulse wave can be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A.

Ex. 1014 ¶ 25 (emphasis added); *see also id.* ¶ 27 ("detecting element 2 is stably fixed").

We credit Dr. Kenny's testimony that a person of ordinary skill in the art would have been motivated by such teachings to apply a cover with a convex surface to Aizawa to improve that similar device in the same way and to yield predictable results, i.e., to resist movement of the sensor on the

user's wrist and to suppress variation. *See, e.g.*, Ex. 1003 ¶¶ 77 ("[T]his contact between the convex surface and the user's skin is said to prevent slippage, which increases the strength of the signals obtainable by Ohsaki's sensor."), 79 (One of ordinary skill would have understood that this would "improve adhesion between the user's wrist and the sensor's surface, improve detection efficiency."). We find persuasive Dr. Kenny's explanation that the person of ordinary skill in the art "would have understood that a protruding convex cover would reduce the adverse effects of user movement on signals obtainable by photodetectors which are positioned to detect light reflected from user tissue." Ex. 1060 ¶ 13.

Indeed, Ohsaki expressly compares the performance of a wrist-worn pulse wave sensor depending on whether translucent board 8 is convex or flat, and concludes the convex surface results in improved performance over the flat surface, especially when the user is moving. Ex. 1014, Figs. 4A–4B, ¶¶ 15, 25 (stating that with "a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist 4," and with "a convex surface like the present embodiment, the variation of the amount of the reflected light" collected by the sensor "is suppressed"). Ohsaki also states that, with a convex surface, "[i]t is also prevented that noise such as disturbance light from the outside penetrates the translucent board 8." *Id.* ¶ 25.

We also credit Dr. Kenny's testimony that the proposed modification would have been within the skill level of an ordinary artisan. For example, Dr. Kenny testifies that one of ordinary skill would have combined the teachings of Aizawa and Ohsaki as "doing so would have amounted to nothing more than the use of a known technique to improve similar devices

in the same way" and the combined elements "would each perform similar functions they had been known to perform prior to the combination." Ex. 1003 ¶ 80. In particular, one of ordinary skill would have recognized that by incorporating Ohsaki's convex surface, "'the convex surface of the translucent board . . . is in intimate contact with the surface of the user's skin'; this contact between the convex surface and the user's skin is said to prevent slippage, which increases the strength of the signals obtainable by Ohsaki's sensor." *Id.* ¶ 77 (citing Ex. 1014 ¶¶ 15, 17, 25, Figs. 1, 2, 4A, 4B).

In light of Ohsaki's express disclosure of the benefits of a convex cover, we credit Dr. Kenny's testimony that a person of ordinary skill in the art would have been motivated to modify Aizawa as proposed, and would have had a reasonable expectation of success in doing so.

We next address Patent Owner's first through third arguments, each of which implicates Petitioner's first and second asserted rationales of improved adhesion and detection efficiency.

Patent Owner's first argument is premised on the notion that Ohsaki's benefits only can be realized with a rectangular convex surface, because such a shape is required to avoid interacting with bones on the back of the user's forearm. PO Resp. 11–30. We disagree. Ohsaki does not disclose the shape of its convex cover, much less require it be rectangular. In fact, Ohsaki is silent as to the shape of the convex surface. Ohsaki discloses that sensor 1 includes detecting element 2, which includes package 5 within which the sensor components are located. Ex. 1014 ¶ 17. Ohsaki's convex surface is located on board 8, which is "attached to the opening of the

package 5." *Id.* Ohsaki provides no further discussion regarding the shape of board 8 or its convex protrusion.

We disagree with Patent Owner's suggestion that the shape of the convex surface can be inferred to be rectangular from Ohsaki's Figures 1 and 2. PO Resp. 11–12. Ohsaki does not indicate that these figures are drawn to scale, or reflect precise dimensions or shapes of the convex surface. *See, e.g.*, Ex. 1014 ¶ 13 ("schematic diagram"); *see also* Pet. Reply 8–16; *Hockerson-Halberstadt, Inc. v. Avia Group Int'l, Inc.*, 222 F.3d 951, 956 (Fed. Cir. 2000) ("[I]t is well established that patent drawings do not define the precise proportions of the elements and may not be relied on to show particular sizes if the specification is completely silent on the issue.").

To be clear, Ohsaki describes the shape of *detecting element 2* as rectangular: "[T]he length of the detecting element 2 from the right side to the left side in FIG. 2 is longer than the length from the upper side to the lower side." Ex. 1014 ¶ 19. Ohsaki also describes that detecting element 2 is aligned longitudinally with the user's forearm: "[I]t is desirable that the detecting element 2 is arranged so that its longitudinal direction agrees with the longitudinal direction of the user's arm," to avoid slipping off. *Id.*; *see also id.* ¶ 9 ("The light emitting element and the light receiving element are arranged in the longitudinal direction of the user's arm.").

In light of this disclosed rectangular shape of detecting element 2, it is certainly possible that Ohsaki's convex surface may be similarly shaped. But, it may not be. Contrary to Patent Owner's argument, Ohsaki neither describes nor requires detecting element 2 to have the same shape as the convex surface of board 8. *Accord* Pet. Reply 13–14 (noting also that

"Ohsaki never describes the 'translucent board 8' as 'longitudinal,' and nowhere describes 'translucent board 8' and 'detecting element 2' as having the same shape."). We have considered the testimony of both Dr. Kenny and Dr. Madisetti on this point. Ex. 1060 ¶¶ 8–16; Ex. 2004 ¶¶ 36–39 (relying on Ohsaki's Figures 1–2 to support his opinion that the convex surface is rectangular). Dr. Madisetti's reliance on the dimensions of Ohsaki's figures is unpersuasive. *Hockerson-Halberstadt*, 222 F.3d at 956. We credit Dr. Kenny's testimony that Ohsaki does not describe its convex surface as rectangular, because this testimony is most consistent with Ohsaki's disclosure.

Further, Patent Owner suggests that the convex surface *must be* rectangular, in order to avoid interacting with bones in the user's forearm. PO Resp. 24–30; Sur-reply 4–8, 10 ("[A] POSITA would have understood Ohsaki's convex board must ***also*** have a longitudinal shape oriented up-and-down the watch-side of the user's wrist/forearm."). Although Ohsaki recognizes that interaction with these bones can cause problems, *see* Ex. 1014 ¶¶ 6, 19, we do not agree that the *only way* to avoid these bones is by aligning a rectangular cover with the longitudinal direction of the user's forearm. For example, in the annotated Figures provided by Patent Owner, *see* PO Resp. 28, we discern that the circular sensor that purports to depict the proposed modification would *also* avoid the bones in the forearm if it were slightly smaller. Patent Owner provides no persuasive explanation to justify the dimensions it provides in this annotated figure, or to demonstrate that such a large sensor would have been required. Indeed, we discern that it would have been within the level of skill of an ordinary artisan to appropriately size a modified sensor to avoid these well-known anatomical

obstacles. "A person of ordinary skill is also a person of ordinary creativity, not an automaton." *KSR*, 550 U.S. at 421. After all, an artisan must be presumed to know something about the art apart from what the references disclose. *See Jacoby*, 309 F.2d at 516.

Finally, we do not agree with Patent Owner's position that Ohsaki's advantages apply only to rectangular convex surfaces. As discussed, Patent Owner has not shown that Ohsaki's convex surface is rectangular at all. Moreover, even if Ohsaki's convex surface is rectangular, when discussing the benefits associated with a convex cover, Ohsaki does not limit those benefits to a cover of any particular shape. Instead, Ohsaki explains that "detecting element 2 is arranged on the user's wrist 4 so that the convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin," which prevents the detecting element from slipping off the detecting position of the user's wrist. Ex. 1014 ¶ 25; Ex. 1060 ¶ 21. Thus, we agree with Petitioner that Ohsaki's teaching of a convex surface would have motivated a person of ordinary skill in the art to add such a surface to Aizawa's circular-shaped sensor, to improve adhesion as taught by Ohsaki. *See, e.g.*, Pet. 20–23. Nothing in Ohsaki's disclosure limits such a benefit to a specific shape of the convex surface. Ex. 1060 ¶¶ 10–11, 14–23.

Moreover, Ohsaki contrasts the ability to properly receive reflected light with a convex surface as compared to a flat surface and notes that,

> in the case that the translucent board 8 has a convex surface . . . the variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin is suppressed. It is also prevented that noise such as disturbance light from the outside penetrates the translucent board 8.

> Therefore the pulse wave can be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A.

Ex. 1014 ¶ 25; Ex. 1060 ¶¶ 12–13. Again, we agree with Petitioner that Ohsaki's teaching of a convex surface would have motivated a person of ordinary skill in the art to add such a surface to Aizawa's sensor, to improve signal strength, as taught by Ohsaki. *See, e.g.*, Pet. 26–29. Again, nothing in Ohsaki's disclosure limits such a benefit to the shape of the convex surface. Ex. 1060 ¶¶ 10–11, 18–23.

Accordingly, we do not agree that Ohsaki's disclosed advantages attach only to a rectangular convex surface, or would have been inapplicable to the proposed combination of Aizawa and Ohsaki.

We have also considered Patent Owner's arguments that Petitioner's proposed modification would disrupt Aizawa's "circular symmetry." *See* PO Resp. 30–32. We do not agree for the reasons set forth above. Further, Petitioner's proposed modification is not a bodily incorporation. That is, Petitioner does not propose a bodily incorporation of Ohsaki's rectangular board into Aizawa's circular cover, but only modifying Aizawa only to include a cover with a convex surface. Pet. Reply 15–16; Pet. 25. Further, we discern that it would have been within the capability of an ordinarily skilled artisan to eliminate any gap that would have decreased signal strength or quality. Ex. 1060 ¶ 23.

We have considered Patent Owner's second argument, that Ohsaki's benefits are realized only when the sensor and convex surface are placed on the back of the user's wrist, which is the opposite side of the wrist taught by Aizawa. PO Resp. 33–42. We do not agree. As an initial matter, Petitioner does not propose bodily incorporating the references; Petitioner simply

proposes adding a convex cover to Aizawa's sensor, without discussing where Aizawa's sensor is used. *See, e.g.*, Pet. 25. In other words, Petitioner's proposed modification does not dictate any particular placement, whether on the palm side or back side of the wrist.

To be sure, Ohsaki's Figures 3A–3B compare the performance of detecting element 2, including its translucent board 8 having a convex protrusion, and show better performance when the element is attached to the back side of the wrist versus the front side of the wrist, when the user is in motion. *See* Ex. 1014 ¶¶ 23–24, Figs. 3A–3B. However, we do not agree that these figures support Dr. Madisetti's conclusion that "Ohsaki indicates a convex surface only prevents slipping on the back (i.e., watch) side of the wrist in a specific orientation, but tends to slip when used in different locations or orientations" such as the palm side of the wrist—particularly in comparison to a flat surface such as Aizawa's. Ex. 2004 ¶¶ 35, 67. Instead, Ohsaki acknowledges that, even when the detecting element is located "on the front [palm] side of the user's wrist 4, *the pulse wave can be detected well* if the user is at rest." Ex. 1014 ¶ 23 (emphasis added). Thus, Ohsaki discloses that, in at least some circumstances, a convex surface located on the front of the user's wrist achieves benefits. *Id.* Notably, Ohsaki's claims are not limited to detection during movement or exercise.

We credit, instead, Dr. Kenny's testimony that a person of ordinary skill in the art would have understood from Ohsaki that a convex protrusion will help prevent slippage, even in the context of Aizawa's sensor. *See* Ex. 1060 ¶¶ 10–11, 24–30. This is because the convex protrusion "promot[es] 'intimate contact with the surface of the user's skin,'" which "would have increased adhesion and reduced slippage of Aizawa's sensor

when placed on either side of a user's wrist or forearm, and additionally would have provided associated improvements in signal quality." *Id.* ¶¶ 29–30 ("additional adhesive effect").

Dr. Madisetti testifies that

> [b]ased on Aizawa's teaching that a flat acrylic plate improves adhesion on the palm side of the wrist, and Ohsaki's teaching that a convex surface tends to slip on the palm side of the wrist, a [person of ordinary skill in the art] would have come to the opposite conclusion from Dr. Kenny: that modifying Aizawa's "flat cover . . . to include a lens/protrusion . . . similar to Ohsaki's translucent board" would <u>*not*</u> "improve adhesion."

Ex. 2004 ¶ 85; *see also id.* ¶ 67. We disagree with this reading of Aizawa. It is true that Aizawa's plate 6 is illustrated as having a flat surface (Ex. 1006, Fig. 1(b)), and that Aizawa states the plate "improve[s] adhesion" (*id.* ¶ 13). Aizawa further states: "the above belt 7 is fastened such that the acrylic transparent plate 6 becomes close to the artery 11 of the wrist 10," and "[t]hereby, adhesion between the wrist 10 and the pulse rate detector 1 is improved." *Id.* ¶ 26. These disclosures, however, indicate the improved adhesion is provided by the acrylic material of plate 6, not the shape of the surface of the plate, which is never specifically addressed. *See also id.* ¶¶ 30, 34 ("Since the acrylic transparent plate 6 is provided . . . adhesion between the pulse rate detector 1 and the wrist 10 can be improved."). Aizawa does not associate this benefit of improved adhesion with the surface shape of the plate, but rather, with the existence of an acrylic plate to begin with. Thus, there is no teaching away from using a convex surface to improve the adhesion of Aizawa's detector to the user's wrist.

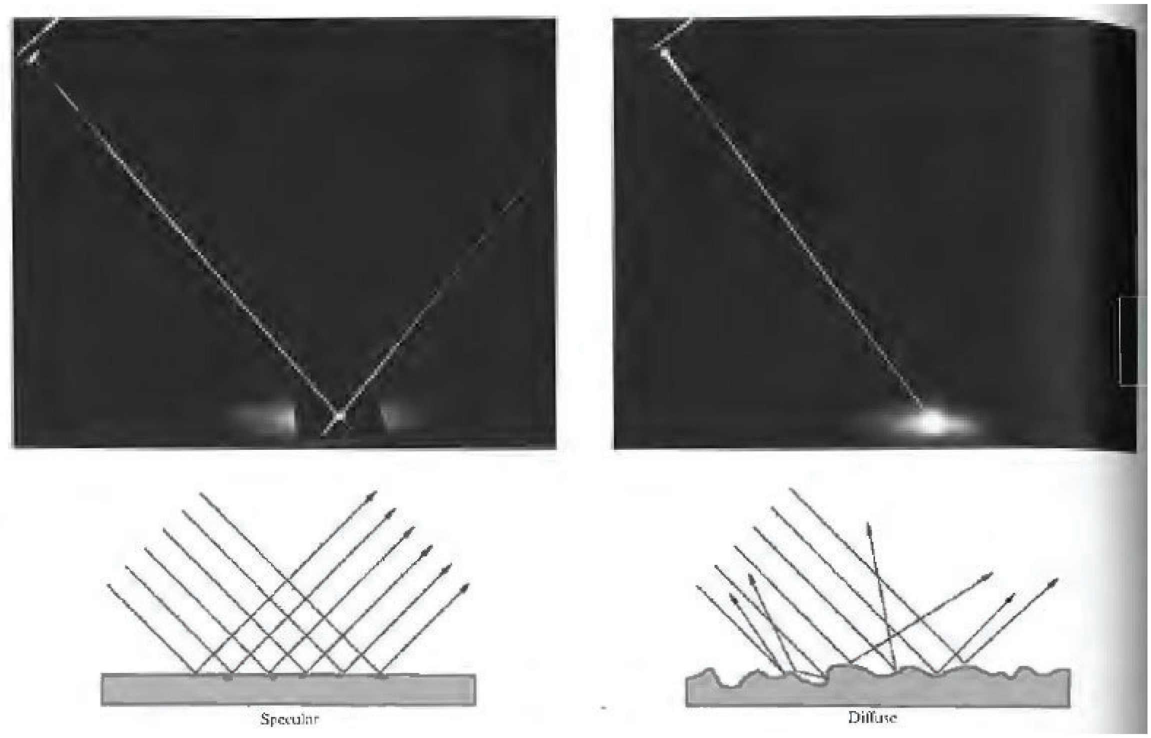
We have considered Patent Owner's third argument that a convex cover would condense light away from Aizawa's peripheral detectors, which

Patent Owner alleges would decrease signal strength. PO Resp. 45–53. We disagree.

There appears to be no dispute that when emitted light passes through user tissue, the light diffuses and scatters as it travels. *See, e.g.*, Pet. Reply 25 ("[R]eflectance-type sensors work by detecting light that has been 'partially reflected, transmitted, absorbed, and scattered by the skin and other tissues and the blood before it reaches the detector," thus, a person of ordinary skill in the art "would have understood that light that backscatters from the measurement site after diffusing through tissue reaches the active detection area from random directions and angles.") (quoting Ex. 1063, 86); Sur-reply 16 ("Even Petitioner admits that tissue randomly scatters and absorbs light rays.").

The light thus travels at random angles and directions, and no longer travels in a collimated and perpendicular manner. Exhibit 1061,[8] Figure 4.12, illustrates the difference between diffuse and collimated light, and is reproduced below:

[8] Eugene Hecht, *Optics* (2nd ed. 1990).



This figure provides at left a photograph and an illustration showing incoming collimated light reflecting from a smooth surface, and at right a photograph and an illustration of incoming collimated light reflecting from a rough surface. *See* Ex. 1061, 87–88 (original page numbers). The smooth surface provides specular reflection, in which the reflected light rays are collimated like the incoming light rays. *See id.* The rough surface provides diffuse reflection, in which the reflected light rays travel in random directions. *See id.*; *see also* Ex. 1060 ¶ 46 ("A [person of ordinary skill in the art] would have understood that light which backscatters from the measurement site after diffusing through tissue reaches the active detection area provided from various random directions and angles.").

Dr. Kenny testifies that Aizawa "detect[s] light that has been 'partially reflected, transmitted, absorbed, and scattered by the skin and other tissues and the blood before it reaches the detector.'" Ex. 1060 ¶ 46 (quoting

Ex. 1063, 86). Dr. Kenny further opines that a convex cover, when added to Aizawa's sensor with multiple detectors symmetrically arranged about a central light source, allows light rays that otherwise would have missed the detection area to instead be directed toward that area as they pass through the interface provided by the cover, thus increasing the light-gathering ability of Aizawa's sensor. *Id.* ¶¶ 47–49.

By contrast Dr. Madisetti testifies that "a convex cover condenses light passing through it towards the center of the sensor and away from the periphery." Ex. 2004 ¶ 87; *see also id.* ¶¶ 82, 86. We have considered this testimony, however, Dr. Madisetti's opinions largely are premised upon the behavior of collimated and perpendicular light as depicted in Figure 14B of the challenged patent. *See id.* ¶ 89. Dr. Madisetti does not explain how light would behave when approaching the sensor from various angles, as it would after being reflected by tissue. *Id.* ¶¶ 87–90. In other words, even if Patent Owner is correct that the '366 patent's Figure 14B depicts light condensing toward the center, this is not dispositive to the proposed modification, because light reflected by a user's tissue is scattered and random, and is not collimated and perpendicular as shown in Figure 14B. Ex. 1001, Fig. 14B.

Patent Owner and Dr. Madisetti argue that "Petitioner and Dr. Kenny both admit that a convex cover condenses light towards the center of the sensor and away from the periphery," in a different petition filed against a related patent, i.e., in IPR2020-01520. PO Resp. 46–47; Ex. 2004 ¶¶ 87–88. The cited portions of the Petition and Dr. Kenny's declaration from IPR2020-01520 discuss a decrease in the "mean path length" of a ray of light when it travels through a convex lens rather than through a flat surface. *See, e.g.*, Ex. 2020 ¶¶ 118–120. We do not agree that this discussion is

inconsistent with Dr. Kenny's testimony here that, where light is reflected to the detectors at various random angles and directions, more light will reach Aizawa's symmetrically disposed detectors when travelling through the convex surface than would be reached without such a surface, because light that might have otherwise missed the detectors now will be captured. *See, e.g.*, Ex. 1060 ¶¶ 49, 55 ("Ohsaki's convex cover provides a slight refracting effect, such that light rays that may have otherwise missed the detection area are instead directed toward that area"). We do not discern that the convergence of a single ray of light toward the center, as discussed in IPR2020-01520, speaks to the aggregate effect on *all* light that travels through the convex surface.

We additionally do not agree with Patent Owner's argument that Petitioner's Reply presents new arguments and evidence that should have been first presented in the Petition, to afford Patent Owner an adequate opportunity to respond. *See* Sur-reply 16–19. The Petition proposed a specific modification of Aizawa to include a convex protrusion in the cover, for the purpose of increasing the light gathering ability of Aizawa's device. *See* Pet. 26–29. The Patent Owner Response then challenged that contention, with several arguments that Petitioner's proposed convex protrusion would not operate in the way the Petition alleges it would operate. *See* PO Resp. 45–53. This opened the door for Petitioner to provide, in the Reply, arguments and evidence attempting to rebut the contentions in the Patent Owner Response. *See* PTAB Consolidated Trial Practice Guide (Nov. 2019) ("Consolidated Guide"),[9] 73 ("A party also may submit rebuttal

[9] Available at https://www.uspto.gov/TrialPracticeGuideConsolidated.

evidence in support of its reply.”). This is what Petitioner did here. The Reply does not change Petitioner’s theory for obviousness; rather, the Reply presents more argument and evidence in support of the same theory for obviousness presented in the Petition. *Compare* Pet. 26–29, *with* Pet. Reply 20–30.

Rationale 3

Petitioner further contends that a person of ordinary skill in the art would have recognized that a cover with a protruding convex surface, such as that taught by Ohsaki, would “protect the elements within the sensor housing” of Aizawa. Pet. 28. We are persuaded that adding a convex cover, such as that taught by Ohsaki, would also protect the sensor’s internal components in a manner similar to Aizawa’s flat acrylic plate. Ex. 1003 ¶ 79; *see also* Ex. 1008 ¶ 15 (noting that a cover “protect[s] the LED or PD”).

We disagree with Patent Owner’s fourth argument that a person of ordinary skill in the art would not have modified Aizawa as proposed because a convex cover would be prone to scratches and because other alternatives existed. Patent Owner does not explain how the potential presence of scratches on a convex cover would preclude that cover’s ability to, nonetheless, protect the internal sensor components in Aizawa, as Petitioner proposes. That a convex cover may be more prone to scratches than Aizawa’s flat cover is one of numerous tradeoffs that a person of ordinary skill in the art would consider in determining whether the benefits of increased adhesion, signal strength, and protection outweigh the potential for a scratched cover. *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006). The totality of the final record does not support that the

possibility of scratches alone would have dissuaded a person of ordinary skill in the art from the proposed modification, to achieve the benefits identified by Petitioner.

For the foregoing reasons, we are persuaded by Petitioner's contentions.

viii. Summary

For the foregoing reasons, we determine that Petitioner has met its burden of demonstrating by a preponderance of the evidence that claim 1 would have been obvious over the cited combination of references.

6. Dependent Claims 2–12

Petitioner also contends that claims 2–12 would have been obvious based on the same combination of prior art addressed above. These challenged claims all depend directly or indirectly from independent claim 1. Petitioner identifies teachings in the prior art references that teach the limitations of these claims, and provides persuasive reasoning as to why the claimed subject matter would have been obvious to one of ordinary skill in the art. Pet. 54–75. Petitioner also supports its contentions for these claims with the testimony of Dr. Kenny. Ex. 1003 ¶¶ 116–148.

Patent Owner does not present any arguments for these claims other than those we have already considered with respect to independent claim 1. PO Resp. 66 ("[T]he Petition fails to establish that independent claims 1, 14, and 27 are obvious in view of the cited references of Ground 1 and therefore fails to establish obviousness of any of the challenged dependent claims.").

We have considered the evidence and arguments of record and determine that Petitioner has demonstrated by a preponderance of the

evidence that claims 2–12 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith for the reasons discussed in the Petition and as supported by the testimony of Dr. Kenny.

For the foregoing reasons, we determine that Petitioner has met its burden of demonstrating by a preponderance of the evidence that claims 1–12 would have been obvious over the cited combination of references.

7. Claims 14–27

Independent claim 14 includes limitations substantially similar to limitations [a], [c]–[h], [j], and [k] and includes additional limitations drawn to "one or more processors configured to: receive information . . . ; [and], process the information to determine physiological parameter measurement information." *Compare* Ex. 1001, 44:57–45:27, *with id.* at 46:33–56. In asserting that claim 14 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith, Petitioner refers to the contentions made regarding claim 1. *See* Pet. 75–76; Ex. 1003 ¶¶ 149–157.

Dependent claims 15–26 all depend directly or indirectly from independent claim 14. Petitioner identifies teachings in the prior art references that teach or suggest the limitations of these claims, and provides persuasive reasoning as to why the claimed subject matter would have been obvious to one of ordinary skill in the art. Pet. 76–81. Petitioner also supports its contentions for these claims with the testimony of Dr. Kenny. Ex. 1003 ¶¶ 158–181.

Independent Claim 27 contains numerous limitations, which are integrated from claim 1 (limitations [a]–[k]) as well as limitations from numerous dependent claims. *Id.* at 48:1–49:10 (reciting also a "touch-screen" and certain "preprocessing electronics"). In asserting that claim 27 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith, Petitioner refers to the contentions made regarding claim 1, as well as claims depending therefrom. Pet. 81–84; Ex. 1003 ¶¶ 183–210.

Patent Owner does not present any arguments for these claims other than those we have already considered with respect to independent claim 1. PO Resp. 66 ("[T]he Petition fails to establish that independent claims 1, 14, and 27 are obvious in view of the cited references of Ground 1 and therefore fails to establish obviousness of any of the challenged dependent claims.").

For the same reasons discussed above, we determine that Petitioner has met its burden of demonstrating by a preponderance of the evidence that claims 14–27 would have been obvious over the cited combination of references and as supported by the testimony of Dr. Kenny. *See supra* II.D.5; Ex. 1003 ¶¶ 149–210.

E. Obviousness over the Combined Teachings of Aizawa, Mendelson-2003, Ohsaki, Goldsmith, and Sherman

Petitioner contends that claim 13 of the '366 patent would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, Goldsmith, and Sherman. Pet. 84–88; *see also* Pet. Reply 37–38. Patent Owner disagrees. PO Resp. 66–67; *see also* Sur-reply 29.

Based on our review of the parties' arguments and the cited evidence of record, we determine that Petitioner has met its burden of showing by a preponderance of the evidence that claim 13 is unpatentable.

1. Overview of Sherman (Ex. 1047)

Sherman is a patent titled "Magnetic Clasp for Wristwatch Strap," and it relates to use of magnetizable material embedded in thermoplastic material with rows of alternating magnetic poles. Ex. 1047, codes (54), (57). Sherman discloses a magnetic fastening mechanism for "wrist instruments," such as wristwatches. *Id.* at 1:4–10. Sherman's system provides "an improved clasp for a flexible strap which eliminates buckles or other types of protruding members" and is "secured, yet easy to engage when desired." *Id*. at 2:1–11. As shown below in Figure 2 of Sherman, the mechanism includes a pair of flexible strap ends having "permanently magnetizable material" of opposite polarities in addition to "mutually nesting uniformly spaced protuberances and indentations." *Id*. at 2:43–62, Fig. 2.

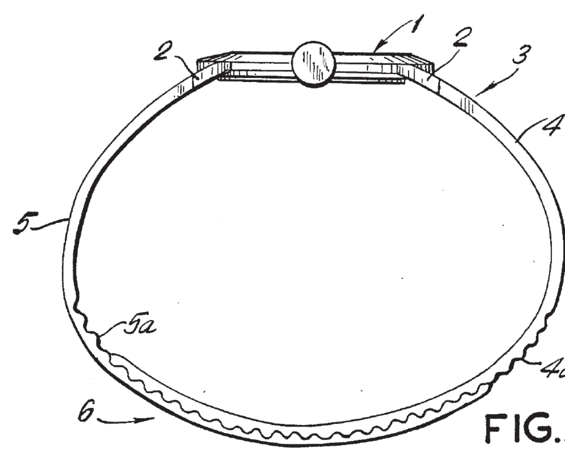


FIG.2

Figure 2 of Sherman depicts an end elevational view showing the wristwatch and strap with transverse ridges 4a and 5a incorporating magnetic securing materials. *Id.*

2. Dependent Claim 13

Claim 13 additionally requires "a magnet configured to be used as a connecting mechanism." Ex. 1001, 46:31–32. Petitioner contends that it would have been obvious for a person of ordinary skill in the art to have modified the sensor system of Aizawa-Ohsaki-Goldsmith to integrate a magnetic connection as taught by Sherman. Pet. 84–88.

Petitioner's Contentions

Petitioner contends that although Goldsmith generally discloses a fastener, Goldsmith "provides no details describing the fastener," but that a person of ordinary skill in the art "would have been motivated to look to other wearable, wrist worn devices such as Sherman's, for details regarding a mechanism for fastening a monitoring device." Pet. 86 (citing Ex. 1003 ¶¶ 211–214). Petitioner contends a person of ordinary skill in the art would have been motivated to add Sherman's magnetic connection in order to be more visually appealing, prevent corners from catching upon clothing, and to prevent broken connectors or accidental snagging. *Id.* (citing Ex. 1047, 1:11–24; Ex. 1003 ¶ 212).

Patent Owner's Contentions

Patent Owner disputes Petitioner's contentions. Patent Owner argues that Petitioner's proposed combination relies on Sherman solely for its alleged disclosure of a magnetic connector, but Ohsaki already includes a series of dedicated belts designed to exert a specific pressure on the user's wrist. PO Resp. 67 (citing Ex. 1014 ¶18). Patent Owner alleges that a person of ordinary skill in the art would have understood that any advantage from Ohsaki's convex board would also require Ohsaki's specific

attachment arrangement, which includes belts and a cushion to prevent movement, yet, Petitioner does not explain how Sherman would have allowed consistent attachment pressure for its sensor as required by Ohsaki. *Id.* (citing Ex. 1014 ¶ 18); *see also* Sur-reply 29 ("Ohsaki teaches a specialized attachment mechanism having specific features to "stably fix[]" the detecting element to the wrist and improve signal-to-noise."). Thus, Patent Owner contends that the person of ordinary skill in the art would not have been motivated to incorporate Sherman's magnetic attachment mechanism into Petitioner's proposed combination. *Id.* (citing Ex. 2004 ¶ 122); *see also* Sur-reply 29.

Analysis

We are persuaded by Petitioner's evidence and argument that a person of ordinary skill in the art would have been motivated to combine Sherman's teaching of a magnetic connection in the existing combination of references. We find persuasive Dr. Kenny's testimony that a person of ordinary skill in the art would have understood from Ohsaki itself that a particular strap is not required to obtain the benefits of Ohsaki's convex cover. Ex. 1060 ¶ 72 (noting that "nothing in Ohsaki links the benefits of its convex cover to the use of any particular type of strap."). Further, we are persuaded by Dr. Kenny's testimony that "[t]he combination involves nothing more than applying a known technique to fasten two ends of a strap for attaching a wrist worn device to a user's arm." Ex. 1003 ¶ 214. In light of the totality of the record, including Dr. Kenny's testimony, we determine that a person of ordinary skill in the art would have been motivated to employ Sherman's magnetic connector because the pressure range required for Ohsaki's

benefits could be achieved by any number of connection fastening mechanisms.

Further, Patent Owner's arguments do not persuasively address Petitioner's proposed combination. *See* Pet. 25–29, 86–88. Ohsaki was relied upon for its teaching that a convex surface protruding into a user's skin will, *inter alia*, prevent slippage. *See id.*; *see also* Ex. 1060 ¶ 11; Ex. 1014, 25, Figs. 4A, 4B. As discussed above, we found persuasive Dr. Kenny's testimony that a person of ordinary skill in the art would have had reason, in view of that teaching, to modify the Aizawa's sensor's flat cover to include a protrusion, so as to improve adhesion between the user's wrist and the sensor's surface, improve detection efficiency, and protect the elements within the sensor housing. *See* Ex. 1003 ¶¶ 76–80. The resulting sensor features Aizawa's cover modified in view of Ohsaki, not Ohsaki's translucent board. Ex. 1060 ¶ 7. Likewise, Patent Owner does not effectively rebut Dr. Kenny's testimony that a person of ordinary skill in the art would have integrated a magnetic connector in the combination of references in view of Sherman for reasons related to engagement and user comfort. *See* PO Resp. 66–67; Ex. 1003 ¶¶ 213–214 ("because it provided details of a wrist-worn device fastening mechanism that addresses the above-noted problems, is easy to engage, and improves user comfort"); Ex. 1060 ¶ 72.

3. Conclusion

We have considered the evidence and arguments of record, including those directed to claim 1 and addressed above, and we determine that Petitioner has demonstrated by a preponderance of the evidence that claim

13 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, Goldsmith, and Sherman for the reasons discussed in the Petition and as supported by the testimony of Dr. Kenny. *See, e.g.*, Pet. 84–88; Ex. 1047, 1:11–25, Fig. 2; Ex. 1003 ¶¶ 211–216.

III. CONCLUSION

In summary:[10]

Claims	35 U.S.C. §	Reference(s)/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–12, 14–27	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith	1–12, 14–27	
13	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith, Sherman	13	
Overall Outcome			1–27	

[10] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

Case: 22-1972 Document: 33 Page: 83 Filed: 05/01/2023

IV. ORDER

Upon consideration of the record before us, it is:

ORDERED that claims 1–27 of the ’366 patent have been shown to be unpatentable; and,

FURTHER ORDERED that, because this is a final written decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

Case: 22-1972 Document: 13-4 Page: 3 Filed: 05/11/2022

PETITIONER:

Walter K. Renner
Roberto J. Devoto
Hyun Jin In
FISH & RICHARDSON P.C.
axf-ptab@fr.com
devoto@fr.com
in@fr.com

PATENT OWNER:

Jarom D. Kesler
Stephen W. Larson
Joseph R. Re
Jacob L. Peterson
Stephen C. Jensen
KNOBBE, MARTENS, OLSON, & BEAR, LLP
2jzk@knobbe.com
2swl@knobbe.com
2jrr@knobbe.com
2jup@knobbe.com
2scj@knobbe.com

Trials@uspto.gov
571-272-7822

Paper 7
Entered: May 5, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

MASIMO CORPORATION,
Patent Owner.

IPR2020-01713
Patent 10,624,564 B1

Before JOSIAH C. COCKS, ROBERT L. KINDER, and AMANDA F. WIEKER, *Administrative Patent Judges.*

KINDER, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background

Apple Inc. ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1–30 ("challenged claims") of U.S. Patent No. 10,624,564 B1 (Ex. 1001, "the '564 patent"). Paper 2 ("Pet."). Masimo Corporation ("Patent Owner") waived filing a preliminary response. Paper 6 ("PO Waiver").

We have authority to determine whether to institute an *inter partes* review, under 35 U.S.C. § 314 and 37 C.F.R. § 42.4. An *inter partes* review may not be instituted unless it is determined that "the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314 (2018); *see also* 37 C.F.R. § 42.4(a) (2020) ("The Board institutes the trial on behalf of the Director.").

For the reasons provided below and based on the record before us, we determine that Petitioner has demonstrated a reasonable likelihood that Petitioner would prevail in showing the unpatentability of at least one of the challenged claims. Accordingly, we institute an *inter partes* review on all grounds set forth in the Petition.

B. Related Matters

The parties identify the following matters related to the '564 patent:

Masimo Corporation v. Apple Inc., Civil Action No. 8:20-cv-00048 (C.D. Cal.);

Case: 22-1972 Document: 34-4 Page: 327 Filed: 05/01/2023

Apple Inc. v. Masimo Corporation, IPR2020-01520 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,258,265 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01521 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,292,628 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01523 (PTAB Sept. 9, 2020) (challenging claims of U.S. Patent No. 8,457,703 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01524 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,433,776 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01526 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 6,771,994 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01536 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01537 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01538 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01539 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01714 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01715 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01716 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,194 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01722 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01723 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01733 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,195 B1); and

Apple Inc. v. Masimo Corporation, IPR2020-01737 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,709,366 B1).

Pet. 3; Paper 3, at 1, 3–4.

Patent Owner further identifies certain issued patent applications, as well as other pending and abandoned applications, that claim priority to, or share a priority claim with, the ’564 patent. Paper 3, at 1–2.

C. The ’564 Patent

The ’564 patent is titled “Multi-Stream Data Collection System for Noninvasive Measurement of Blood Constituents,” and issued on April 21, 2020, from U.S. Patent Application No. 16/725,292, filed December 23, 2019. Ex. 1001, codes (21), (22), (45), (54). The ’564 patent claims priority through a series of continuation and continuation-in-part applications to Provisional Application Nos. 61/086,060, 61/086,108, 61/086,063, and 61/086,057, each filed on August 4, 2008, as well as 61/091,732 filed on

August 25, 2008, and 61/078,228 and 61/078,207 both filed on July 3, 2008.[1] *Id.* at codes (60), (63).

The '564 patent discloses a two-part data collection system including a noninvasive sensor that communicates with a patient monitor. *Id.* at 2:47–51. The sensor includes a sensor housing, an optical source, and several photodetectors, and is used to measure a blood constituent or analyte, e.g., oxygen or glucose. *Id.* at 2:38–46, 3:4–6. The patient monitor includes a display and a network interface for communicating with a handheld computing device. *Id.* at 2:54–57.

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[1] The Office has made the prior determination that the application leading to the '564 patent is not designated as an "AIA (FITF)" application. *See* Ex. 1002 at 102 (Notice of Allowability of March 3, 2020). We determine that based on this prior determination, and the lack of any contrary evidence before us, the Petition was not required to be filed more than nine months after the date of the grant of the patent. *See* 37 C.F.R. § 42.102(a)(1). Instead, based on the record before us, 37 C.F.R. § 42.102(a)(2) should apply, which allows a petition to be filed after "the date of the grant of the patent."

Figure 1 of the ’564 patent is reproduced below.

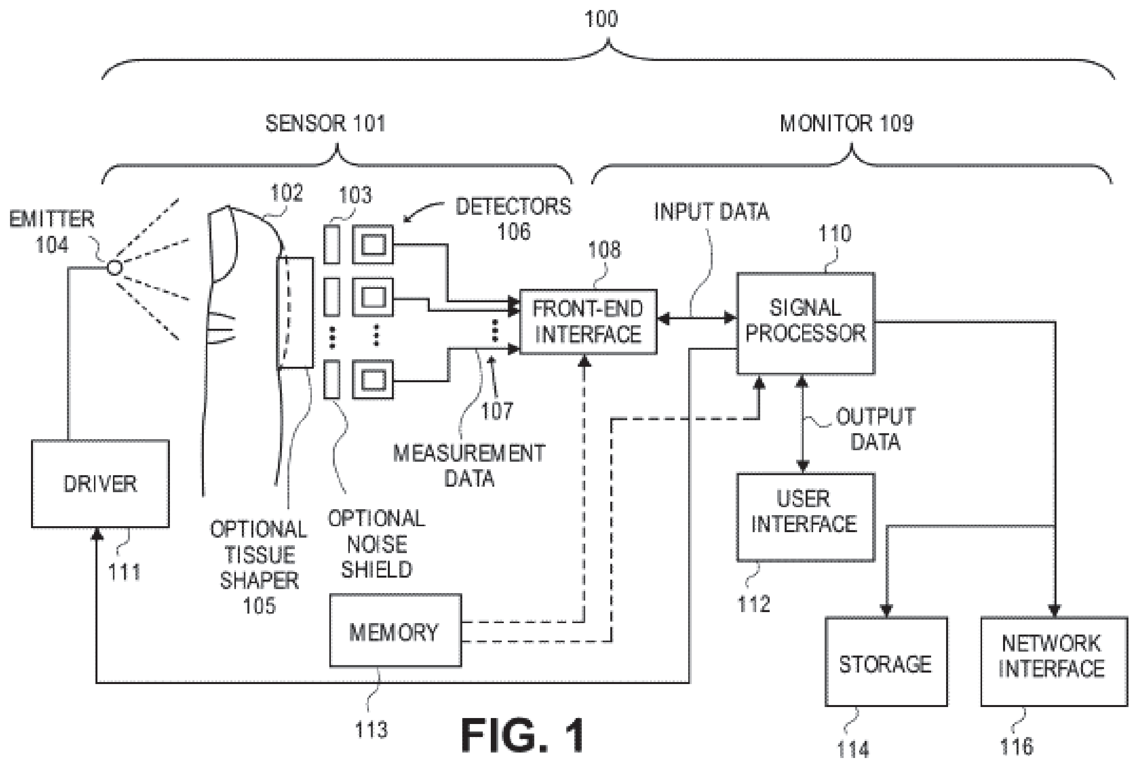

FIG. 1

Figure 1 illustrates a block diagram of data collection system 100 including sensor 101 and monitor 109. *Id.* at 11:56–67. Sensor 101 includes emitter 104 and detectors 106. *Id.* at 12:1–5. Emitter 104 emits light that is attenuated or reflected by the patient’s tissue at measurement site 102. *Id.* at 14:11–16. Detectors 106 capture and measure the light attenuated or reflected from the tissue. *Id.* In response to the measured light, detectors 106 output detector signal 107 to monitor 109 through front-end interface 108. *Id.* at 14:16–19, 36–42. Sensor 101 also may include tissue shaper 105, which may be in the form of a convex surface that: (1) reduces the thickness of the patient’s measurement site; and (2) provides more surface area from which light can be detected. *Id.* at 11:7–23.

Monitor 109 includes signal processor 110 and user interface 112. *Id.* at 15:27–29. “[S]ignal processor 110 includes processing logic that

determines measurements for desired analytes . . . based on the signals received from the detectors 106." *Id.* at 15:32–35. User interface 112 presents the measurements to a user on a display, e.g., a touch-screen display. *Id.* at 15:57–61. In response to user input or device orientation, user interface 112 can "reorient its display indicia." *Id.* at 15:63–67. The monitor may be connected to storage device 114 and network interface 116. *Id.* at 16:4–22. In some embodiments, the monitor, including the display, is attached to the patient by a strap. *Id.* at 17:56–59, 18:16–19.

The '564 patent describes various examples of sensor devices. Figures 14D and 14F, reproduced below, illustrate sensor devices.

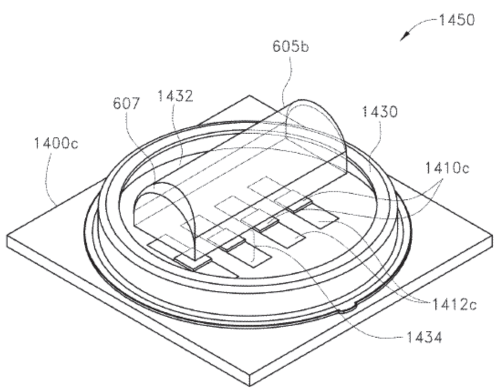

FIG. 14D

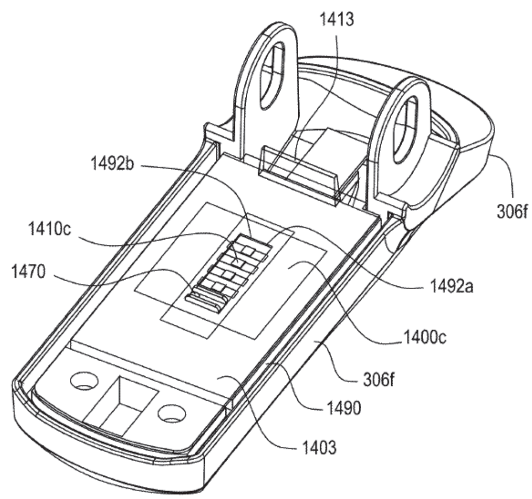

FIG. 14F

Figure 14D illustrates a detector submount and Figure 14F illustrates portions of a detector shell. *Id.* at 6:54–57. As shown in Figure 14D, multiple detectors 1410c are located within housing 1430 and under transparent cover 1432, on which protrusion 605b is disposed. *Id.* at 36:40–47. Figure 14F illustrates detector shell 306f including detectors 1410c on substrate 1400c. *Id.* at 37:20–21. In some embodiments, the detector shell includes walls to separate individual photodiode arrays and to "prevent or

reduce mixing of light signals." *Id.* at 22:46–53. Substrate 1400c is enclosed by shielding enclosure 1490 and noise shield 1403, which include window 1492a and window 1492b, respectively, placed above detectors 1410c. *Id.* at 22:20–36.

Figures 4A and 4B, reproduced below, illustrate an alternative example of a tissue contact area of a sensor device.

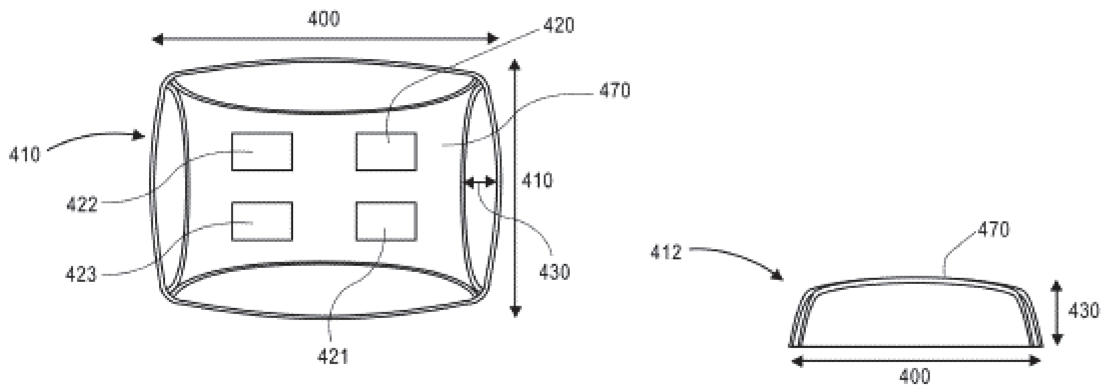

FIG. 4A FIG. 4B

Figures 4A and 4B illustrate arrangements of protrusion 405 including measurement site contact area 470. *Id.* at 23:30–36. "[M]easurement site contact area 470 can include a surface that molds body tissue of a measurement site." *Id.* "For example, the measurement site contact area 470 can be generally curved and/or convex with respect to the measurement site." *Id.* at 23:53–55. The measurement site contact area includes windows 420–423 that "mimic or approximately mimic a configuration of, or even house, a plurality of detectors." *Id.* at 23:61–24:8.

D. Illustrative Claim

Of the challenged claims, claim 1 is independent. Claim 1 is illustrative and is reproduced below.

1. A user-worn physiological measurement device comprising:

[a] one or more emitters configured to emit light into tissue of a user;

[b] at least four detectors arranged on a substrate;

[c] a cover comprising a protruding convex surface, wherein the protruding convex surface extends over all of the at least four detectors arranged on the substrate, wherein at least a portion of the protruding convex surface is rigid;

[d] one or more processors configured to: receive one or more signals from at least one of the at least four detectors, the one or more signals responsive to at least a physiological parameter of the user; and process the one or more signals to determine measurements of the physiological parameter;

[e] a network interface configured to communicate with a mobile phone;

[f] a touch-screen display configured to provide a user interface,

[g] wherein: the user interface is configured to display indicia responsive to the measurements of the physiological parameter, and

[h] an orientation of the user interface is configurable responsive to a user input;

[i] a wall that surrounds at least the at least four detectors, wherein the wall operably connects to the substrate and the cover;

[j] a storage device configured to at least temporarily store at least the measurements of the physiological parameter; and

[k] a strap configured to position the physiological measurement device on the user.

Ex. 1001, 44:63–45:29 (bracketed lettering [a]–[k] added).

E. Applied References

Petitioner relies upon the following references:

> Sherman et al., U.S. Patent No. 4,941,236, filed July 6, 1989, issued July 17, 1990 (Ex. 1013, "Sherman");
>
> Ali et al., U.S. Patent No. 6,584,336 B1, filed March 1, 2000, issued June 24, 2003 (Ex. 1019, "Ali");
>
> Ohsaki et al., U.S. Patent Application Publication No. 2001/0056243 A1, filed May 11, 2001, published December 27, 2001 (Ex. 1009, "Ohsaki");
>
> Aizawa, U.S. Patent Application Publication No. 2002/0188210 A1, filed May 23, 2002, published December 12, 2002 (Ex. 1006, "Aizawa");
>
> Rantala et al., U.S. Patent No. 6,912,413 B2, filed September 12, 2003, issued June 28, 2005 (Ex. 1022, "Rantala"); and
>
> Goldsmith et al., U.S. Patent Application Publication No. 2007/0093786 A1, filed July 31, 2006, published April 26, 2007 (Ex. 1011, "Goldsmith).

Pet. 10.

Petitioner also submits, *inter alia*, the Declaration of Thomas W. Kenny, Ph.D. (Ex. 1003).

F. Asserted Grounds

Petitioner asserts that claims 1–30 are unpatentable based upon the following grounds (Pet. 9):

Claim(s) Challenged	35 U.S.C. §	References/Basis
1–10 and 13–30	103	Aizawa, Ohsaki, and Goldsmith
11	103	Aizawa, Ohsaki, Goldsmith, and Sherman
12	103	Aizawa, Ohsaki, Goldsmith, and Rantala
1–10 and 13–30	103	Aizawa, Ohsaki, Goldsmith, and Ali
11	103	Aizawa, Ohsaki, Goldsmith,

Claim(s) Challenged	35 U.S.C. §	References/Basis
		Ali, and Sherman
12	103	Aizawa, Ohsaki, Goldsmith, Ali, and Rantala

II. DISCUSSION

A. Claim Construction

For petitions filed on or after November 13, 2018, a claim shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b) (2020). Accordingly, we construe the claims according to the standard set forth in *Phillips v. AWH Corp.,* 415 F.3d 1303 (Fed. Cir. 2005). Based on our analysis of Petitioner's challenges presented at this stage of the proceeding, we find that one claim term requires express construction.

Petitioner raises the issue of the proper scope of the claim term "processor" to a person of ordinary skill in the art. Pet. 51. Petitioner submits "[t]he '564 patent does not define 'processor,'" but argues that a person of ordinary skill in the art would understand the term to mean "part of a computer system that operates on data," consistent with the definition provided in Merriam-Webster's Collegiate Dictionary.[2] *Id.*; Ex. 1012, 5.

First, we observe that the claim language provides an understanding of the functions of the claimed one or more processers, which are "configured to:" "receive one or more signals" and "process the one or more signals to determine measurements of the physiological parameter."

[2] Petitioner adds page numbers 1–6 to Exhibit 1012. We refer to the added page numbers when citing to Exhibit 1012 in this Decision.

Ex. 1001, 45:6–12. The Specification describes several distinct processors, but it also describes a "signal processor" as the device used for processing signals. *See, e.g.*, *id.* at 9:50–55, 14:36–42, 15:27–56, 33:36–47. Based on the current record before us, we adopt Petitioner's definition of the term "processor." *See* Ex. 1012, 5. This definition is consistent with the general operation of the signal processor in the '564 patent, where the signal processor is described to include "processing logic that determines measurements . . . based on the signals received from the detectors." Ex. 1001, 15:31–35; 15:35–39 ("signal processor 110 can be implemented using one or more microprocessors or subprocessors . . ., digital signal processors, application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), combinations of the same").

We also offer guidance as to the meaning of "an orientation of the user interface is configurable responsive to a user input" also found in claim 1. To determine the meaning of the claim limitation "an orientation of the user interface is configurable responsive to a user input," we look to the Specification of the '564 patent. The Specification states "the user interface 112 can include a flip screen, a screen that can be moved from one side to another on the monitor 109, or can include an ability to reorient its display indicia responsive to user input or device orientation." Ex. 1001, 15:63–67. Based on the evidence before us, and based on limited discussion of "orientation" in the '564 patent, we understand the claim limitation "an orientation of the user interface is configurable responsive to a user input" to at least encompass reorienting the display indicia responsive to user input.

Based on our analysis of the issues in dispute at this stage of the proceeding, we conclude that no further claim terms require express

construction at this time. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Matal*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

B. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103 if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of non-obviousness.[3] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). When evaluating a combination of teachings, we must also "determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue." *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). Whether a combination of prior art elements would have produced a predictable result weighs in the ultimate determination of obviousness. *Id.* at 416–417.

In an *inter partes* review, the petitioner must show with particularity why each challenged claim is unpatentable. *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016); 37 C.F.R. § 42.104(b). The

[3] Patent Owner does not present objective evidence of non-obviousness at this stage.

burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

C. Level of Ordinary Skill in the Art

Petitioner identifies the appropriate level of skill in the art as that possessed by a person having "a Bachelor of Science degree in an academic discipline emphasizing the design of electrical, computer, or software technologies, in combination with training or at least one to two years of related work experience with capture and processing of data or information." Pet. 8 (citing Ex. 1003 ¶¶ 21–22). Petitioner also notes that "[a]dditional education in a relevant field or industry experience may compensate for one of the other aspects of the [person of ordinary skill in the art]" described above. *Id.*

For purposes of this Decision, we generally adopt Petitioner's assessment as set forth above, which appears consistent with the level of skill reflected in the Specification and prior art.

D. Obviousness over the Combined Teachings of Aizawa, Ohsaki, and Goldsmith

Petitioner presents undisputed contentions that claims 1–10 and 13–30 of the '564 patent would have been obvious over the combined teachings of Aizawa, Ohsaki, and Goldsmith. Pet. 10–91.

1. Overview of Aizawa (Ex. 1006)

Aizawa is a U.S. patent application publication titled "Pulse Wave Sensor and Pulse Rate Detector," and discloses a pulse wave sensor that

detects light output from a light emitting diode and reflected from a patient's artery. Ex. 1006, codes (54), (57).

Figure 1(a) of Aizawa is reproduced below.

FIG. 1 (a)

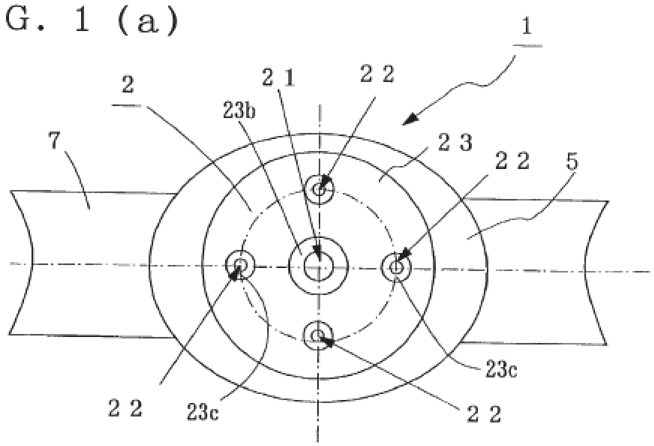

Figure 1(a) is a plan view of a pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(a), pulse wave sensor 2 includes light emitting diode ("LED") 21, four photodetectors 22 symmetrically disposed around LED 21, and holder 23 for storing LED 21 and photodetectors 22. *Id.* Aizawa discloses that, "to further improve detection efficiency, . . . the number of the photodetectors 22 may be increased." *Id.* ¶ 32, Fig. 4(a). "The same effect can be obtained when the number of photodetectors 22 is 1 and a plurality of light emitting diodes 21 are disposed around the photodetector 22." *Id.* ¶ 33.

Figure 1(b) of Aizawa is reproduced below.

FIG. 1 (b)

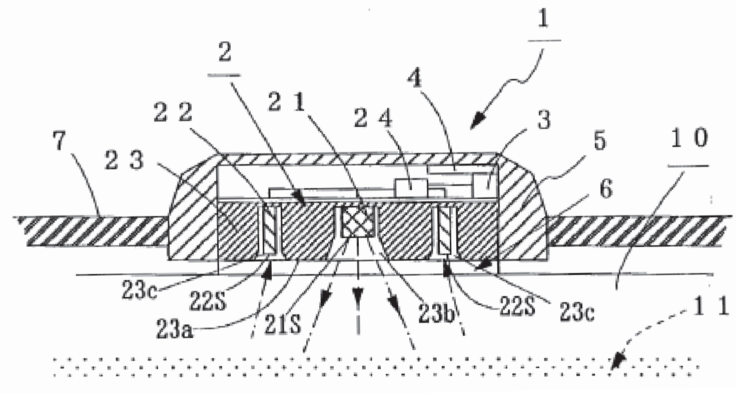

Figure 1(b) is a sectional view of the pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(b), pulse wave sensor 2 includes drive detection circuit 24 for detecting a pulse wave by amplifying the outputs of photodetectors 22. *Id.* ¶ 23. Arithmetic circuit 3 computes a pulse rate from the detected pulse wave and transmitter 4 transmits the pulse rate data to an "unshown display." *Id.* The pulse rate detector further includes outer casing 5 for storing pulse wave sensor 2, acrylic transparent plate 6 mounted to detection face 23a of holder 23, and attachment belt 7. *Id*.

Aizawa discloses LED 21 and photodetectors 22 "are stored in cavities 23*b* and 23*c* formed in the detection face 23*a*" of the pulse wave sensor. *Id.* ¶ 24. Detection face 23a "is a contact side between the holder 23 and a wrist 10, respectively, at positions where the light emitting face 21*s* of the light emitting diode 21 and the light receiving faces 22*s* of the photodetectors 22 are set back from the above detection face 23*a*." *Id*. Aizawa further discloses that "a subject carries the above pulse rate detector 1 on the inner side of his/her wrist 10 with a belt in such a manner that the light emitting face 21*s* of the light emitting diode 21 faces down (on the wrist 10 side)." *Id.* ¶ 26. Furthermore, "the above belt 7 is fastened such

that the acrylic transparent plate 6 becomes close to the artery 11 of the wrist 10. Thereby, adhesion between the wrist 10 and the pulse rate detector 1 is improved." *Id.* ¶¶ 26, 34.

2. *Overview of Ohsaki (Ex. 1009)*

Ohsaki is a U.S. patent application publication titled "Wristwatch-type Human Pulse Wave Sensor Attached on Back Side of User's Wrist," and discloses an optical sensor for detecting a pulse wave of a human body. Ex. 1009, code (54), ¶ 3. Figure 1 of Ohsaki is reproduced below.

FIG. 1

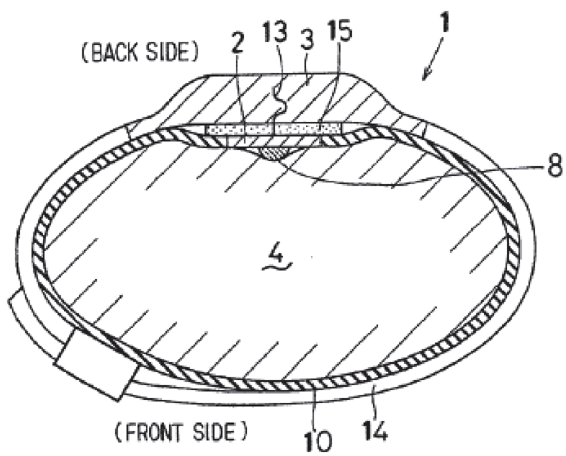

Figure 1 illustrates a cross-sectional view of pulse wave sensor 1 attached on the back side of user's wrist 4. *Id.* ¶¶ 12, 16. Pulse wave sensor 1 includes detecting element 2 and sensor body 3. *Id.* ¶ 16.

Figure 2 of Ohsaki, reproduced below, illustrates further detail of detecting element 2.

FIG. 2

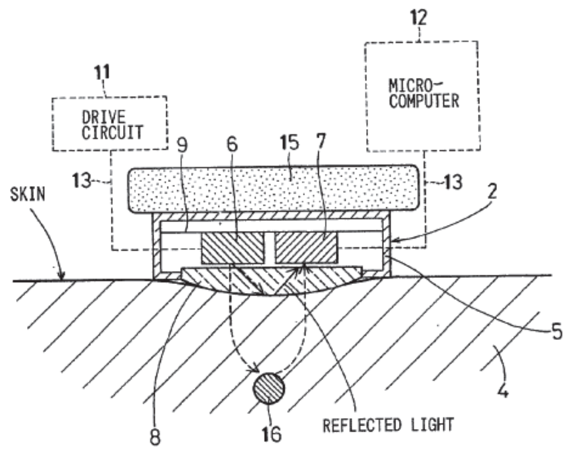

Figure 2 illustrates a mechanism for detecting a pulse wave. *Id.* ¶ 13. Detecting element 2 includes package 5, light emitting element 6, light receiving element 7, and translucent board 8. *Id.* ¶ 17. Light emitting element 6 and light receiving element 7 are arranged on circuit board 9 inside package 5. *Id.*

"[T]ranslucent board 8 is a glass board which is transparent to light, and attached to the opening of the package 5. A convex surface is formed on the top of the translucent board 8." *Id.* "[T]he convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin," preventing detecting element 2 from slipping off the detecting position of the user's wrist. *Id.* ¶ 25. Ohsaki describes that when a translucent board has a flat surface, the detected pulse wave may be adversely affected by movement of the user's wrist. *Id.* By preventing the detecting element from slipping, the convex surface suppresses "variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the

user's skin." *Id.* Additionally, the convex surface prevents penetration by "noise such as disturbance light from the outside." *Id.*

Sensor body 3 is connected to detecting element 2 by signal line 13. *Id.* ¶ 20. Signal line 13 connects detecting element 2 to drive circuit 11, microcomputer 12, and a monitor display (not shown). *Id.* Drive circuit 11 drives light emitting element 6 to emit light toward wrist 4. *Id.* Detecting element 2 receives reflected light which is used by microcomputer 12 to calculate pulse rate. *Id.* "The monitor display shows the calculated pulse rate." *Id.*

3. Overview of Goldsmith (Ex. 1011)

Goldsmith is a U.S. patent application publication titled "Watch Controller for a Medical Device," and discloses a watch controller device that communicates with an infusion device to "provid[e] convenient monitoring and control of the infusion pump device." Ex. 1011, codes (54), (57).

Goldsmith's Figure 9A and 9B are reproduced below.

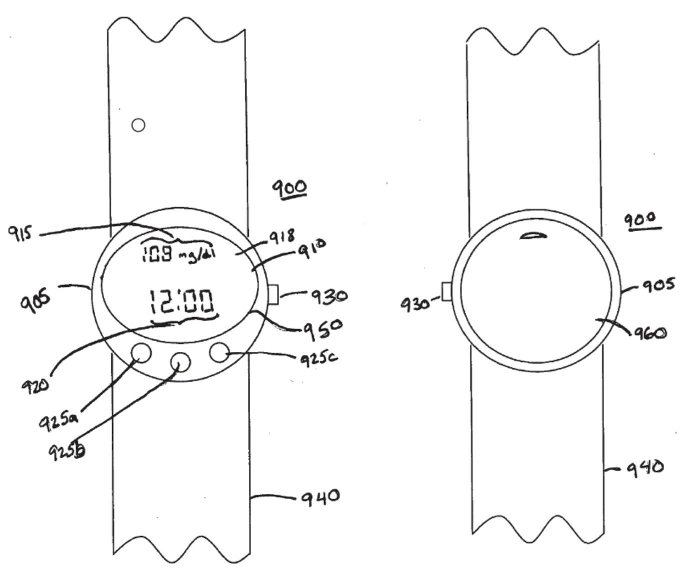

FIG.9A FIG 9B

Figure 9A and Figure 9A are respective front and rear views of a combined watch and controller device. *Id.* ¶¶ 30–31. As shown in Figure 9A, watch controller 900 includes housing 905, transparent member 950, display 910, input devices 925a–c, scroll wheel 930, and wrist band 940. *Id.* ¶¶ 85–86. Figure 9B shows rear-side cover 960, and a rear view of housing 905, scroll wheel 930, and wrist band 940. *Id*.

Goldsmith discloses the watch controller may interact with one or more devices, such as infusion pumps or analyte monitors. *Id.* ¶ 85; *see also id.* ¶ 88 ("The analyte sensing device 1060 may be adapted to receive data from a sensor, such as a transcutaneous sensor."). Display 910 "may display at least a portion of whatever information and/or graph is being displayed on the infusion device display or on the analyte monitor display," such as, e.g., levels of glucose. *Id.* ¶ 86. The display is customizable in a variety of configurations including user-customizable backgrounds, languages, sounds, font (including font size), and wall papers. *Id.* ¶¶ 102, 104. Additionally, the watch controller may communicate with a remote station, e.g., a computer, to allow data downloading. *Id.* ¶ 89 (including wireless). The remote station may also include a cellular telephone to be "used as a conduit for remote monitoring and programming." *Id*.

4. *Independent Claim 1 (Aizawa, Ohsaki, and Goldsmith)*

Petitioner presents undisputed contentions that claim 1 would have been obvious over the combined teachings of Aizawa, Ohsaki, and Goldsmith. Pet. 10–63.

i. "[pre] A user-worn physiological measurement device comprising"

On this record, the cited evidence supports Petitioner's undisputed contentions that Aizawa discloses this limitation. Pet. 41–42.

Figure 2 of Aizawa shows a user wearing a pulse wave sensor on the inner side of his/her wrist. Ex. 1006 ¶ 0026. Accordingly, Petitioner's reliance on Figure 2 of Aizawa and the corresponding disclosure sufficiently disclose the subject matter of the preamble.[4] *See* Pet. 42.

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported.[5]

ii. "[a] one or more emitters configured to emit light into tissue of a user"

On this record, the cited evidence supports Petitioner's undisputed contentions that Aizawa discloses a pulse wave sensor including LED 21 that emits light into a user's tissue. Pet. 42–43; Ex. 1006 ¶ 23 ("LED 21 . . . for emitting light having a wavelength of a near infrared range"), ¶ 27 (explaining that light is emitted toward the wrist), Fig. 1(b) (depicting

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[4] Whether the preamble is limiting need not be resolved at this stage of the proceeding, because Petitioner shows sufficiently for purposes of institution that the recitation in the preamble is satisfied by the prior art.

[5] Petitioner further contends that the subject matter of the preamble is taught by the combination of Aizawa, Ohsaki, and Goldsmith. Pet. 41–42 (arguing that it would have been obvious to incorporate the pulse wave sensor of Aizawa (as modified by Ohsaki) into the wrist-worn watch controller device in Figures 9A and 9B of Goldsmith, to realize a user-worn physiological measurement device). Because Figure 2 of Aizawa teaches a user-worn physiological measurement device, further analysis of the combination of Aizawa, Ohsaki, and Goldsmith is not necessary for this particular claim limitation.

LED 21 facing user wrist 10), Fig. 2 (depicting a pulse wave sensor worn on a user's wrist).

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported.

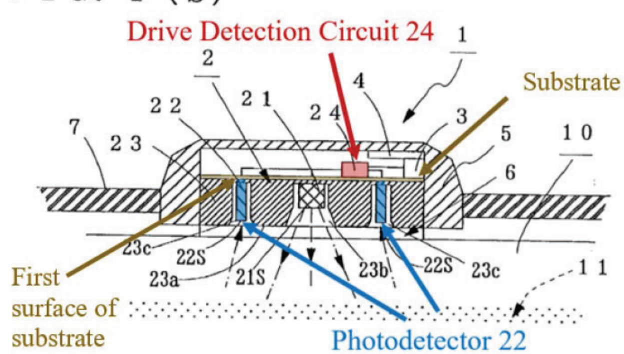
iii. "[b] at least four detectors arranged on a substrate"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 44–46.

Petitioner contends that pulse wave sensor depicted in Figure 1(a) of Aizawa discloses four photodetectors 22. Pet. 44; *see e.g.*, Ex. 1006 ¶ 27 ("[F]our photodetectors 22 are disposed around the light emitting diode 21.").

Relying on the cross-section view of Figure 1(b) of the pulse wave detector of Aizawa, Petitioner further contends photodetectors 22 are secured on a substrate illustrated in Petitioner's annotated Figure 1(b). Pet. 24, 45. Petitioner's annotated Figure 1(b) of Aizawa is reproduced below.

FIG. 1 (b)



Annotated Figure 1(b) depicts a structure, identified by Petitioner with brown highlight and the added label "Substrate," arranged in proximity to photodetectors 22. Pet. 45. Petitioner concedes that Aizawa "does not label

or describe" a substrate, but contends a person of ordinary skill in the art ("POSITA") would have understood that "Aizawa's photodetectors are secured to the [physiological measure device] . . . through such [as] a substrate" depicted in annotated Figure 1(b). Pet. 24. Dr. Thomas W. Kenny testifies that "[a] POSITA would have understood that the substrate provides physical support and electrical connectivity and is connected to the holder 23." Ex. 1003 ¶ 71; *see also* Pet. 24 (citing to testimony of Dr. Kenny). On the current record, Petitioner has sufficiently shown that the structure identified in annotated Figure 1(b) of Aizawa is a substrate, and that photodetectors 22 are arranged on the substrate.

Petitioner further contends that if Aizawa is found not to disclose a substrate, then Ohsaki teaches this feature. Pet. 25. Similar to the device of Aizawa, Ohsaki teaches a pulse wave sensor comprising a light emitting element 6 (*e.g.,* a LED) and a light receiving element (*e.g.,* a photodetector). Ex. 1009 ¶ 17. "The light emitting element 6 and light receiving element 7 are . . . arranged on the circuit board 9." *Id.* Relying on the testimony of Dr. Kenny, Petitioner contends a POSITA would have modified the pulse wave sensor of Aizawa to include a substrate, such as circuit board 9 of Ohsaki, to secure the photodetectors of Aizawa and enable the detectors to send signals to other elements in the device. Pet. 25 (citing Ex. 1003 ¶¶ 72–73; Ex. 1006 ¶¶ 2–5, 8–16, 23, 27–29, 32–33, Figs. 1, 2, 3, 4(a); Ex. 1009 ¶ 17, Fig. 2).

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

iv. "[c] a cover comprising a protruding convex surface, wherein the protruding convex surface extends over all of the at least four detectors arranged on the substrate, wherein at least a portion of the protruding convex surface is rigid"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding these limitations. Pet. 19–23, 47–49.

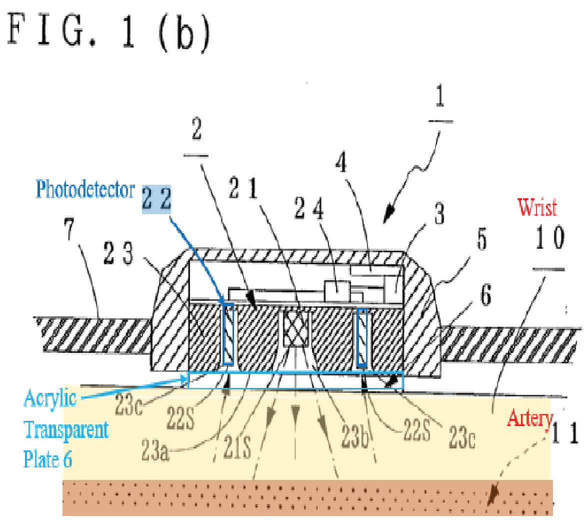
Petitioner contends the pulse wave sensor depicted in Figure 1(b) of Aizawa comprises "a flat transparent plate 6 that contacts the user's wrist." Pet. 19; *see, e.g.*, Ex. 1006 ¶ 26 ("[T]he acrylic transparent plate 6 becomes close to the artery 11 of the wrist 10."). In Petitioner's view, the flat plate of Aizawa is unfavorable, in that it "would have slipped along the user's wrist, resulting in variations in the light detected by the photodetectors." Pet. 20.

Petitioner proposes modifying the flat acrylic plate of Aizawa, with the convex translucent board 8 depicted in Figure 2 of Ohsaki. Specifically, Petitioner relies on Ohsaki's teaching:

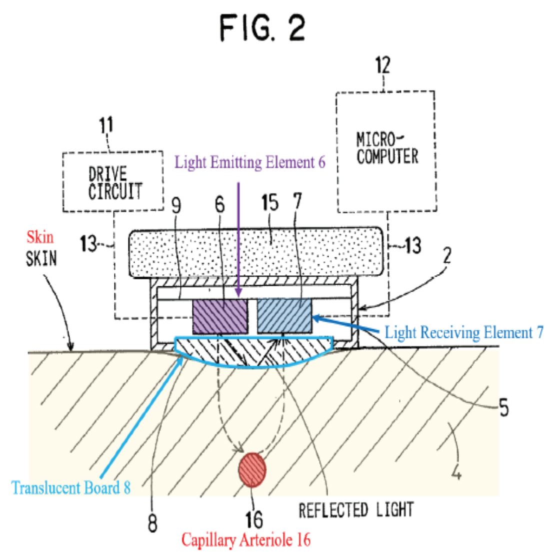
> Ohsaki explains that "if the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist as shown in FIG. 4B," but that if "the translucent board 8 has a convex surface…variation of the amount of the reflected light…that reaches the light receiving element 7 is suppressed." APPLE-1009, ¶[0025]. Thus, when a protruding convex cover is used, "the pulse wave can be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A." *Id.*

Pet. 21–22 (citing Ex. 1009 ¶ 25); *see also* Ex. 1009, Fig. 2 (depicting convex translucent board 8).

Petitioner's annotated Figure 1(b) of Aizawa and annotated Figure 2 of Ohsaki are reproduced below.



APPLE-1006, FIG. 1(b).

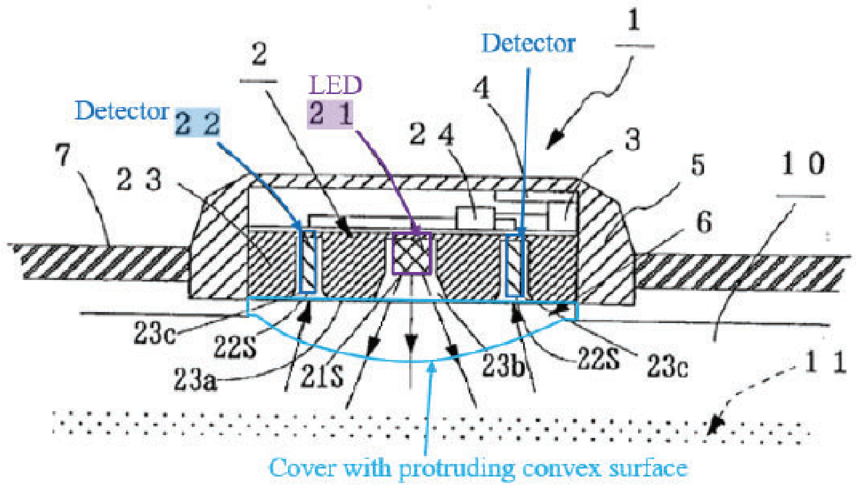


APPLE-1009, FIG. 2.

Annotated Figure 1(b) of Aizawa (left) depicts acrylic transparent plate 6 (in which Petitioner equates to the claimed "cover" and highlighted in blue) in contact with the wrist 10 of a user and annotated Figure 2 of Ohsaki (right) depicts a translucent board 8 including a convex surface (highlighted in blue) in contact with a user's skin. Pet. 20–21. Notably, transparent plate 6 of Aizawa appears flat. Pet. 20.

Petitioner's presents a modified Figure 1(b) of Aizawa to demonstrate the proposed modification to Aizawa based on Ohsaki's teaching of a protruding convex surface.

F I G. 1 (b)



APPLE-1006, FIG. 1(b) (after modification).

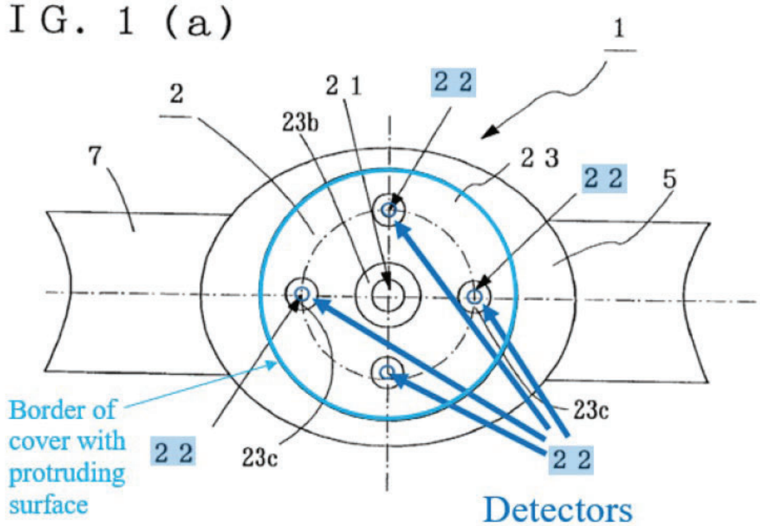
Modified Figure 1(b) depicts acrylic transparent plate 6 of Aizawa modified according to the teaching of Ohsaki, to include a "protruding convex surface" (highlighted in blue). Pet. 23. Petitioner contends that a person of ordinary skill in the art "would have modified Aizawa's flat cover to include a protruding convex surface . . . to improve adhesion between the user's wrist and the sensor, improve detection efficiency, and protect the elements within the housing." Pet. 22–23 (citing Ex. 1003 ¶¶ 69–70; Ex. 1009 ¶ 25); *see also* Pet. 47.

Aizawa's flat plate 6 is made of acrylic (Ex. 1006 ¶ 23) and Ohsaki's convex translucent board 8 is made of glass (Ex. 1009 ¶ 17). Dr. Kenny testifies that the protruding convex surface in the Aizawa/Ohsaki pulse wave sensor (shown in modified Figure 1(b) of Aizawa) "would have had rigidity to cause the user's skin to deform and to create friction to prevent slippage and realized improved adhesion between the user's wrist and the sensor device's surface." Ex. 1003 ¶ 105; *see also* Pet. 49. We find persuasive Petitioner's stated reasoning for modifying the cover of Aizawa. We also

find persuasive the unrebutted testimony of Dr. Kenny regarding the cover's rigidity.

Petitioner further contends the convex protruding cover of Aizawa (as modified by Ohsaki) "would have extended over all of the at least four detectors arranged on the substrate." Pet. 49. In support of this contention, Petitioner provides annotated Figure 1(a) of Aizawa, reproduced below. *Id.*

FIG. 1 (a)



Annotated Figure 1(a) depicts the border of the protruding convex surface (depicted in modified Figure 1(b) of Aizawa) extending over four photodetectors 22. Pet. 49.

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

v. "[d] one or more processors configured to: receive one or more signals from at least one of the at least four detectors, the one or more signals responsive to at least a physiological parameter of the user; and process the one or more signals to determine measurements of the physiological parameter"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding these limitations. Pet. 50–52.

Petitioner contends arithmetic circuit 3 and drive detection circuit 24 in Figure 1(b) of Aizawa equate to the claimed "one or more processors." Pet. 51. The drive detection circuit and arithmetic circuit are described respectively by Aizawa as configured to detect a pulse wave by amplifying the output of photodetectors 22, and compute a pulse rate from the detected pulse wave data. Ex. 1006 ¶ 23. Petitioner contends that the term "processor" should be interpreted to mean "part of computer system that operates on data," and that a POSITA would understand the operation of the drive detection circuit and arithmetic circuit are consistent with this definition. Pet. 51 (citing Ex. 1003 ¶¶ 107–108). As noted *supra* at §(II)(A), we adopt preliminarily Petitioner's definition of processor.

Petitioner also contends Goldsmith discloses "a processor that executes programs to control sensing devices, receives data indicative of a concentration of an analyte, and displays a representation of at least a portion of the information received from or displayed by other devices." Pet. 51–52 (citing Ex. 1011 ¶ 88, Figs. 6A, 6B, 10). Figure 10 of Goldsmith depicts a combined watch and controller device. Ex. 1011 ¶ 32. The watch controller device includes processor 1012, which is "adapted to process data and commands inputted by the user." *Id.* ¶ 88. Dr. Kenny testifies the controller device is "'used with any number of…diagnostic devices' and

sensors to obtain physiological measurements such as temperature, blood glucose level, oxygen level, and heart rate." Ex. 1003 ¶ 109; *see also* Ex. 1011 ¶¶ 82, 95. Dr. Kenny appears to suggest that because Goldsmith's watch controller device can be configured in a number of diagnostic devices, the watch controller device can also be used in connection with the pulse wave sensor of Aizawa (as modified by Ohsaki). Dr. Kenny further testifies that a POSITA would have found it obvious to incorporate the pulse wave sensor of Aizawa (as modified by Ohsaki) into the watch controller device of Goldsmith "such that Goldsmith's processor would have received signals from the detectors and would have processed the one or more signals to determine and display the pulse rate." Ex. 1003 ¶ 110.

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

vi. "[e] a network interface configured to communicate with a mobile phone"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 32–35, 53.

Petitioner contends "Goldsmith teaches communicating with a cellular phone" (Pet. 32) and "using a transceiver 1018 or a communications block 595 to facilitate communication with remote stations" (Pet. 33 (citing Ex. 1011 ¶¶ 17, 89, Fig. 10)). In the embodiment depicted in Figure 10 of Goldsmith, watch controller device 1010 communicates with a remote station such as a cellular telephone, which "may be used as a conduit for remote monitoring." Ex. 1011 ¶ 89; *see also id.* ¶¶ 16–17 (describing a controller device communicating patient data to a nurse, or other designated person, wirelessly). Communication with the remote station is facilitated by

transmitter/transceiver 1018. *Id.* ¶ 88 ("a transmitter/receiver 1018 . . . transmits such communications").

Dr. Kenny testifies that it would have been obvious to a person of ordinary skill in the art to incorporate the sensor of Aizawa (as modified by Ohsaki) into the watch controller device of Goldsmith, to provide the sensor access to the transceiver/transceiver interface of Goldsmith. Ex. 1003 ¶ 85; *see also* Pet. 35. Dr. Kenny reasons that this combination "would have been predictable" because the watch controller device of Goldsmith is configurable to integrate a sensor, and the combination would provide, among other things, a "means for the user and/or user's family doctor, or emergency services to conveniently receive user health data." Ex. 1003 ¶¶ 85–86; *see also* Pet. 35.

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

vii. "[f] a touch-screen display configured to provide a user interface, [g]wherein: the user interface is configured to display indicia responsive to the measurements of the physiological parameter, and [h] an orientation of the user interface is configurable responsive to a user input"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding these limitations. Pet. 39–41, 53–59.

Petitioner contends that the pulse wave sensor of Aizawa (as modified by Ohsaki and Goldsmith) "would have included a touch-screen display configured to provide a user interface." Pet. 53. Both Aizawa and Ohsaki disclose displaying the physiological data of a user on a display. Ex. 1006 ¶ 35 ("[T]he pulse rate data is transmitted to the display."); Ex. 1009 ¶ 20 ("The monitor display shows the calculated pulse rate."). Dr. Kenny

testifies "that a static, non-touch display would have been inconvenient to the user relative to the touch-screen display that Goldsmith discloses" and that "it would have been obvious to a POSITA to incorporate the Aizawa-Ohsaki sensor into Goldsmith's [watch controller device]." Ex. 1003 ¶¶ 94–97 (describing the ability for a user to zoom in/out on a graph on a touchscreen display, as compared to the inability to zoom in/out on a non-touchscreen display); *see also* Pet. 39–40.

Figure 9A of Goldsmith depicts display 910 of a watch controller device. The display may receive data directly from a sensor transmitter on a patient's skin. Ex. 1011 ¶ 87; *see also* Pet. 54. Goldsmith further discloses configuring the watch controller device with a touchscreen. Ex. 1011 ¶ 93. Petitioner contends that the displays of Aizawa and Ohsaki are similar to the display of Goldsmith, in that they display sensor data. Pet. 53–54 (discussing displaying sensor data on the Goldsmith display and pulse rate data on the Aizawa and Ohsaki displays). In view of the disclosure of Goldsmith, Petitioner proposes integrating the pulse wave sensor of Aizawa (as modified by Ohsaki) into the watch controller device of Goldsmith, so that the modified sensor can transmit data to Goldsmith's touchscreen. Pet. 41. Petitioner reasons a "POSITA would have understood that integrating the Aizawa-Ohsaki sensor into Goldsmith's [watch controller device] . . . would improve the user experience by providing navigation and other options realizable through the touchscreen's user interface." *Id.*; Ex. 1003 ¶ 97.

Petitioner further contends that the orientation of the touchscreen display user interface in the combination of Aizawa, Ohsaki, and Goldsmith would have beeen configurable based on user input. Pet. 55. To support this

contention, Petitioner cites to portions of Goldsmith that disclose configuring display 910 of the watch controller device in Figure 9A with customizable display settings (i.e., background, sounds, fonts, wallpaper) and configurable graphics (i.e., large font sizes). Pet. 56 (citing Ex. 1011 ¶¶ 102, 104); *see also* Ex. 1011 ¶¶ 102, 104 (describing customizable display options). Petitioner also points to the description of the infusion pump device depicted in the embodiment in Figure 2 of Goldsmith, and contends a person of ordinary skill in the art would have understood that Goldsmith's "display can be configured in various different ways to allow the interface to be consistent with the user's preferences and to correct the presentation of information that could be incorrect due to the scaling of graphs of incorrect resolutions." Pet. 55–56 (citing Ex. 1011 ¶ 49).

Goldsmith discloses customizing the display of the watch controller device with settings such as larger font sizes for vision-impaired users or various backgrounds and wallpapers. Ex. 1011 ¶¶ 102, 104. It appears that Petitioner equates the selectable font sizes disclosed by Goldsmith with configuring the orientation of the user interface as required by the claim. Pet. 56 (reasoning that a POSITA would find it obvious to "improve the font size of text" as taught by Goldsmith). At this stage of the proceeding, this interpretation is consistent with our understood meaning of the term "orientation," because the display text (i.e., indicia) of Goldsmith is altered in size (i.e., reoriented). Our current determination is based on the record currently before us, including our claim interpretation discussed *supra*.

Dr. Kenny testifies, a person of ordinary skill in the art would have understood "the ability to configure display graphics would have included configuring the orientation of the [watch controller device] display's user

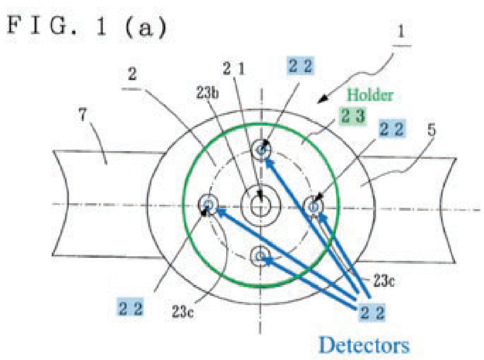
interface based on user input" (Ex. 1003 ¶ 120), and cites to additional references[6] that are not part of this basis for the challenge for claim 1 (the combination of Aizawa, Ohsaki, and Goldsmith) (*id.* ¶¶ 121–122; *see also* Pet. 56–58).

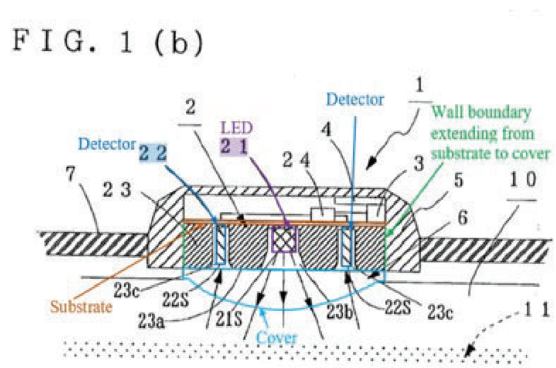
At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

viii. "[i] a wall that surrounds at least the at least four detectors, wherein the wall operably connects to the substrate and the cover"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 59–60.

Petitioner equates the outer surface of holder 23 in Figure 1(b) of Aizawa to the claimed "wall." Pet. 59–60. To illustrate the wall in relation to the photodetectors, substrate, and cover, Petitioner provides annotated Figures 1(a) and 1(b) of Aizawa, reproduced below. Pet. 60–61.





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[6] Petitioner cites additional references King (Ex. 1018) and Ali (Ex. 1019). Pet 56–58. This Decision will address arguments relevant to Ali below, but King is not relied upon as the basis for any of Petitioner's challenges. *See* Pet. 9 (listing the challenges).

Annotated Figure 1(a) (left) depicts a plan view of the pulse wave sensor, where holder 23 (shown as a green circle) surrounds four photodetectors 22, and annotated Figure 1(b) (right) depicts a cross-section view of the pulse wave sensor, where holder 23 surrounds photodetectors 22. Dr. Kenny testifies that the portion of the holder highlighted in green in annotated Figure 1(b) "connects to the substrate and the cover." Ex. 1003 ¶ 125.

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

ix. "[j] a storage device configured to at least temporarily store at least the measurements of the physiological parameter; and"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 36–38, 61.

Aizawa discloses detecting a pulse wave and computing a pulse rate based on the detected pulse wave. Ex. 1006 ¶ 28; Pet. 36. Dr. Kenny testifies that "[w]hile Aizawa does not explicitly describe using a storing device to perform computations, a POSITA would have understood that performing such computations and related operations such as displaying the determined pulse rate, would have involved using a storage device to store pulse rate measurement data." Ex. 1003 ¶ 87; Pet. 36.

The watch controller device in Figure 10 of Goldsmith includes memory 1014 for storing data or controller programs. Ex. 1011 ¶ 91. Dr. Kenny testifies to the obviousness of incorporating the pulse wave sensor of Aizawa (as modified by Ohsaki) into the watch controller device of Goldsmith, such that the incorporated sensor is configured to store data in a memory, to later be reproduced for display or transmission. Ex. 1003

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¶¶ 88–90. Dr. Kenny also testifies "it would have been obvious to a POSITA to incorporate the Aizawa-Ohsaki sensor into Goldsmith's [watch controller device] such that the sensor would have access to a storage device, such as the memory shown in Goldsmith's FIGS. 8 and 10, to store pulse rate data," and that the combination of Aizawa, Ohsaki, and Goldsmith "would have been predictable . . . because Goldsmith's [watch controller device] is configured to integrate a characteristic determining device such as the Aizawa-Ohsaki sensor." Ex. 1003 ¶¶ 90–91; *see also* Ex. 1011 ¶¶ 87, 95 (describing a sensor in contact with a patient's skin and measuring a patient's heart rate).

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

x. "[k] a strap configured to position the physiological measurement device on the user."

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 61–63.

Petitioner contends the pulse wave sensor of Aizawa (as modified by Ohsaki and Goldsmith) would have included wrist band 940 depicted in Figures 9A and 9B of Goldsmith. Pet. 61 ("Goldsmith discloses a strap . . . and the [Aizawa, Ohsaki, Goldsmith physiological measurement device] would have included that strap."); *see also* Ex. 1011 ¶ 85 ("The watch controller device 900 may include a wrist band 940 so that a user may wear the watch controller device 900 on his/her wrist.").

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported.

xi. Summary

For the foregoing reasons, we are persuaded that Petitioner's cited evidence and reasoning demonstrates a reasonable likelihood that Petitioner would prevail in its contentions regarding claim 1.

5. Claims 2–10 and 13–30

Petitioner presents undisputed contentions that dependent claims 2–10 and 13–30, which depend directly or indirectly from independent claim 1, are unpatentable over the combined teachings of Aizawa, Ohsaki, and Goldsmith (Pet. 64–91), and provides arguments explaining how the references teach the limitations of these claims. Pet. 64–91; Ex. 1003 ¶¶ 129–170.

Patent Owner does not offer, at this stage, any arguments addressing Petitioner's substantive showing. *See* PO Waiver. We have reviewed these arguments and the cited evidence, and we determine Petitioner has demonstrated a reasonable likelihood of prevailing as to these contentions.

Moreover, as discussed in detail above, Petitioner has demonstrated a reasonable likelihood of prevailing on the challenge to claim 1 over the combined teachings of Aizawa, Ohsaki, and Goldsmith. Therefore, pursuant to USPTO policy implementing the decision in *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348 (2018) ("*SAS*"), we institute as to all claims challenged in the petition and on all grounds in the petition. *See* PTAB Consolidated Trial Practice Guide (Nov. 2019) ("Consolidated Guide"),[7] 5–6, 64.

[7] Available at https://www.uspto.gov/TrialPracticeGuideConsolidated.

E. Obviousness over the Combined Teachings of Aizawa, Ohsaki, Goldsmith, and Ali

Petitioner challenges the patentability of claims 1–10 and 13–30 based on the combination of Aizawa, Ohsaki, Goldsmith, and Ali. Pet. 9, 99–102. Ali is relied upon to teach limitation [1h] which reads: "an orientation of the user interface is configurable responsive to a user input." Petitioner contends that remaining claim limitations [1a]–[1g] and [1i]–[1k] are unpatentable for the same reasons raised with respect to the challenge of claim 1 based on the combination of Aizawa, Ohsaki, and Goldsmith. Pet. 99 ("Prior art mappings and arguments for all claim features other than [1h] in Ground 4 are the same as in Ground 1.").

1. Overview of Ali

Ali is a U.S. patent titled "Universal/Upgrading Pulse Oximeter," and discloses a portable pulse oximeter unit for measuring a patient's oxygen saturation or other related physiological parameters. Ex. 1019, codes (54), (57). The portable unit includes a display configured to display an image that is "rotatable, either manually . . . or as a function of orientation." *Id.* at code (57). Figures 8B and 8C of Ali are reproduced below.

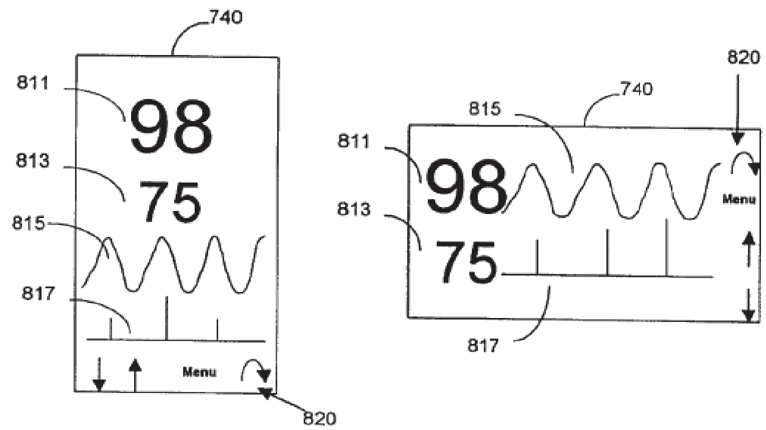

FIG. 8B FIG. 8C

Figure 8B (left) depicts the display of the portable pulse oximeter in portrait mode, and Figure 8C (right) depicts the display of the portable oximeter in landscape mode. *Id.* at 11:62–64. The portrait mode and landscape mode are determined by a gravity-activated tilt sensor or a display mode key. *Id.* at 11:64–12:7.

2. Independent Claim 1 (Aizawa, Ohsaki, Goldsmith, and Ali)

Petitioner presents undisputed contentions that claim 1 would have been obvious over the combined teachings of Aizawa, Ohsaki, Goldsmith, and Ali. Pet. 99–102.

i.[1a]–[1g] and [1i]–[1k]

On this record, the cited evidence supports Petitioner's undisputed contentions regarding these limitations. Pet. 41–54, 59–63.

Petitioner contends claim limitations [1a]–[1g] and [1i]–[1k] are unpatentable for the same reasons raised with respect to Petitioner's

challenge based on Aizawa, Ohsaki, and Goldsmith. Pet. 99. The ground based on Aizawa, Ohsaki, and Goldsmith is addressed *supra* at §§ (II)(D)(4)(i)–(ix). At this stage of the proceeding, Petitioner's stated reasoning with respect to these limitations, and the basis for combining Aizawa, Ohsaki, and Goldsmith, is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

ii. "[h] an orientation of the user interface is configurable responsive to a user input"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation and the rationale for combining Ali with Aizawa, Ohsaki, and Goldsmith. Pet. 99–102.

As noted in our analysis above, Petitioner proposes integrating the pulse wave sensor of Aizawa (as modified by Ohsaki) into the watch controller device of Goldsmith, so that the modified sensor can transmit data to Goldsmith's touchscreen. Pet. 41. Goldsmith notes a problem in displaying images as a result of the display of a controller device and infusion pump having two different resolutions. Ex. 1011 ¶ 49. Acknowledging the image display problem described in Goldsmith, Petitioner contends images displayed on the touchscreen user interface of the pulse wave sensor of Aizawa (as modified by Ohsaki and Goldsmith) "can be incorrect due to screen formatting, scaling, and resolution issues." Pet. 101 (citing Ex. 1011 ¶ 49). Goldsmith further discloses that its display is customizable with different backgrounds, fonts, wallpapers, or font sizes. Ex. 1011 ¶¶ 102, 104.

Figures 8B and 8C of Ali disclose a portable pulse oximeter that displays images, such as pulse rate data, in portrait mode or alternatively in

landscape mode. Ex. 1019, 11:62–64, 12:8–12. Petitioner contends "to address problems in displaying graphs and text as described in Goldsmith, a POSITA would have included Ali's capability to select user interface orientation through a user input such that the user may have greater control over the display and enjoy an improved viewing experience." Pet. 101–102. Dr. Kenny testifies:

> Implementing Ali's capability to select user interface orientation in [Aizawa, Ohsaki, and Goldsmith's physiological measurement device] would have been predictable at least because it would have involved incorporating a feature that was simple to implement and known in the industry. For instance, Ali concedes that its user interface orientation selection feature can easily be implemented through a software program for modifying the display of information. . . . Furthermore, this combination would have addressed a known issue in Goldsmith's user interface, and would require nothing more than applying a known technique, as described by Ali.

Ex. 1003 ¶ 184; *also see* Pet. 102 (citing Ex. 1003).

At this stage of the proceeding, Petitioner's stated reasoning is sufficiently supported, including by the unrebutted testimony of Dr. Kenny.

iii. Summary

For the foregoing reasons, we are persuaded that Petitioner's cited evidence and reasoning demonstrates a reasonable likelihood that Petitioner would prevail in its contentions regarding claim 1 as obvious over Aizawa, Ohsaki, Goldsmith, and Ali.

F. Remaining Grounds of Obviousness

As discussed in detail above, Petitioner has demonstrated a reasonable likelihood of prevailing on the challenge to claim 1 as having been obvious

over Aizawa, Ohsaki, and Goldsmith and also having been obvious over Aizawa, Ohsaki, Goldsmith, and Ali. Therefore, pursuant to USPTO policy implementing the decision in *SAS*, we institute as to all claims challenged in the Petition and on all grounds in the Petition. *See* Consolidated Guide, 5–6, 64.

III. CONCLUSION

The Supreme Court held that a final written decision under 35 U.S.C. § 318(a) must decide the patentability of all claims challenged in the petition. *See SAS*, 138 S. Ct. 1348. After considering the evidence and arguments presented in the Petition, we determine that Petitioner has demonstrated a reasonable likelihood of success in proving that at least claim 1 of the ’564 patent is unpatentable. Accordingly, we institute an *inter partes* review of all claims and all grounds set forth in the Petition.[8]

At this stage of the proceeding, we have not made a final determination as to the patentability of any challenged claim or as to the construction of any claim term.

[8] The Petition addresses the Board’s discretion under 35 U.S.C. §§ 314(a) and 325(d). *See* Pet. 103–108. Patent Owner does not argue that we should exercise discretion to deny institution of *inter partes* review. *See* PO Waiver. Accordingly, we do not consider exercising discretion to deny institution of *inter partes* review under 35 U.S.C. §§ 314(a) and 325(d) any further.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 1–30 of the ’564 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the ’564 patent shall commence on the entry date of this Order, and notice is hereby given of the institution of a trial.

FOR PETITIONER:

W. Karl Renner
Andrew B. Patrick
Usman A. Khan
FISH & RICHARDSON P.C.
axf-ptab@fr.com
patrick@fr.com
khan@fr.com

FOR PATENT OWNER:

Joseph R. Re
Stephen W. Larson
Jarom D. Kesler
Jacob L. Peterson
KNOBBE, MARTENS, OLSON, & BEAR, LLP
2jrr@knobbe.com
2swl@knobbe.com
2jzk@knobbe.com
2jup@knobbe.com

Trials@uspto.gov
571-272-7822

Paper 7
Entered: May 5, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

MASIMO CORPORATION,
Patent Owner.

IPR2020-01716
Patent 10,702,194 B1

Before JOSIAH C. COCKS, ROBERT L. KINDER, and AMANDA F. WIEKER, *Administrative Patent Judges.*

WIEKER, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314, 37 C.F.R. § 42.4

I. INTRODUCTION

A. Background

Apple Inc. ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1–30 ("challenged claims") of U.S. Patent No. 10,702,194 B1 (Ex. 1001, "the '194 patent"). Paper 2 ("Pet."). Masimo Corporation ("Patent Owner") waived filing a preliminary response. Paper 6 ("PO Waiver").

We have authority to determine whether to institute an *inter partes* review, under 35 U.S.C. § 314 and 37 C.F.R. § 42.4. An *inter partes* review may not be instituted unless it is determined that "the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314 (2018); *see also* 37 C.F.R. § 42.4(a) ("The Board institutes the trial on behalf of the Director.").

For the reasons provided below and based on the record before us, we determine that Petitioner has demonstrated a reasonable likelihood that Petitioner would prevail in showing the unpatentability of at least one of the challenged claims. Accordingly, we institute an *inter partes* review on all grounds set forth in the Petition.

B. Related Matters

The parties identify the following matters related to the '194 patent:

Masimo Corporation v. Apple Inc., Civil Action No. 8:20-cv-00048 (C.D. Cal.);

Apple Inc. v. Masimo Corporation, IPR2020-01520 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,258,265 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01521 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,292,628 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01523 (PTAB Sept. 9, 2020) (challenging claims of U.S. Patent No. 8,457,703 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01524 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,433,776 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01526 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 6,771,994 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01536 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01537 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01538 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01539 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01713 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,624,564 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01714 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01715 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01722 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01723 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01733 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,195 B1); and

Apple Inc. v. Masimo Corporation, IPR2020-01737 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,709,366 B1).

Pet. 91; Paper 3, 1–4.

Patent Owner further identifies the following pending patent applications, among other issued and abandoned applications, that claim priority to, or share a priority claim with, the ’194 patent:

U.S. Patent Application No. 16/834,538;

U.S. Patent Application No. 16/449,143; and

U.S. Patent Application No. 16/805,605.

Paper 3, 1–2.

C. The ’194 Patent

The ’194 patent is titled “Multi-Stream Data Collection System for Noninvasive Measurement of Blood Constituents,” and issued on July 7, 2020, from U.S. Patent Application No. 16/829,536, filed March 25, 2020. Ex. 1001, codes (21), (22), (45), (54). The ’194 patent claims priority through a series of continuation and continuation-in-part applications to

Provisional Application Nos. 61/078,228 and 61/078,207, both filed July 3, 2008.[1] *Id.* at codes (60), (63).

The ’194 patent discloses a two-part data collection system including a noninvasive sensor that communicates with a patient monitor. *Id.* at 2:49–51. The sensor includes a sensor housing, an optical source, and several photodetectors, and is used to measure a blood constituent or analyte, e.g., oxygen or glucose. *Id.* at 2:40–46, 3:8–9. The patient monitor includes a display and a network interface for communicating with a handheld computing device. *Id.* at 2:56–59.

Figure 1 of the ’194 patent is reproduced below.

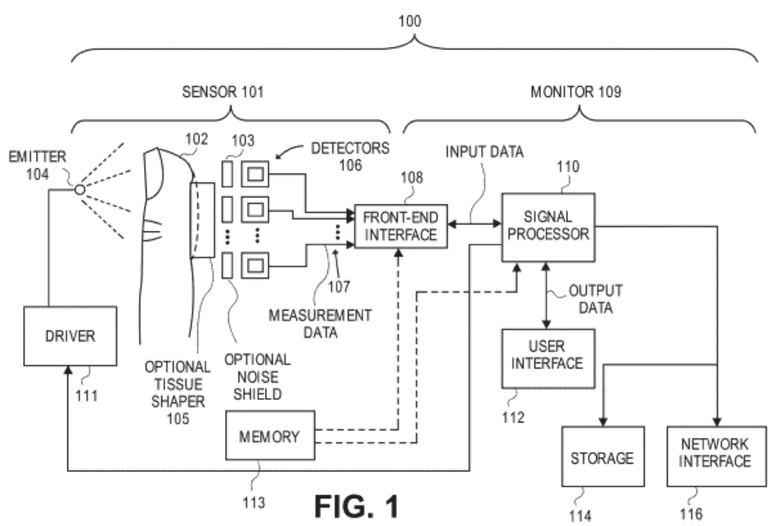

FIG. 1

[1] The Office has made the prior determination that the application leading to the ’194 patent should be examined under the pre-AIA first to invent provisions. *See* Ex. 1002, 199 (Apr. 10, 2020, Decision Granting Request for Prioritized Examination listing “AIA (FITF) Status” as “No”). We determine that based on this prior determination, and the lack of any contrary evidence before us, the Petition was not required to be filed more than nine months after the date of the grant of the patent. *See* 37 C.F.R. § 42.102(a)(1). Instead, based on the record before us, 37 C.F.R. § 42.102(a)(2) should apply, which allows a petition to be filed after “the date of the grant of the patent.”

Figure 1 illustrates a block diagram of data collection system 100 including sensor 101 and monitor 109. *Id.* at 11:56–67. Sensor 101 includes optical emitter 104 and detectors 106. *Id.* at 12:1–5. Emitters 104 emit light that is attenuated or reflected by the patient's tissue at measurement site 102. *Id.* at 14:11–16. Detectors 106 capture and measure the light attenuated or reflected from the tissue. *Id.* In response to the measured light, detectors 106 output detector signals 107 to monitor 109 through front-end interface 108. *Id.* at 14:16–19, 36–42. Sensor 101 also may include tissue shaper 105, which may be in the form of a convex surface that: (1) reduces the thickness of the patient's measurement site; and (2) provides more surface area from which light can be detected. *Id.* at 11:7–23.

Monitor 109 includes signal processor 110 and user interface 112. *Id.* at 15:27–29. "[S]ignal processor 110 includes processing logic that determines measurements for desired analytes . . . based on the signals received from the detectors." *Id.* at 15:32–35. User interface 112 presents the measurements to a user on a display, e.g., a touch-screen display. *Id.* at 15:57–67. The monitor may be connected to storage device 114 and network interface 116. *Id.* at 16:4–22.

The '194 patent describes various examples of sensor devices. Figures 14D and 14F, reproduced below, illustrate sensor devices.

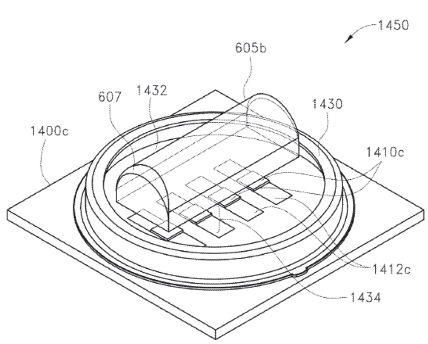

FIG. 14D

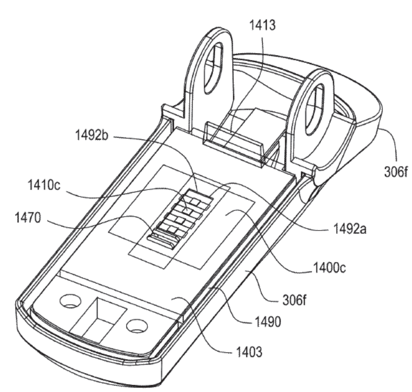

FIG. 14F

Figure 14D illustrates portions of a detector submount and Figure 14F illustrates portions of a detector shell. *Id.* at 6:54–57. As shown in Figure 14D, multiple detectors 1410c are located within housing 1430 and under transparent cover 1432, on which protrusion 605b (or partially cylindrical protrusion 605) is disposed. *Id.* at 35:51–54, 36:45–52. Figure 14F illustrates a detector shell 306f including detectors 1410c on substrate 1400c. *Id.* at 37:25–33. Substrate 1400c is enclosed by shielding enclosure 1490 and noise shield 1403, which include window 1492a and window 1492b, respectively, placed above detectors 1410c. *Id.* Alternatively, cylindrical housing 1430 may be disposed under noise shield 1403 and may enclose detectors 1410c. *Id.* at 37:63–65.

Figures 4A and 4B, reproduced below, illustrate an alternative example of a tissue contact area of a sensor device.

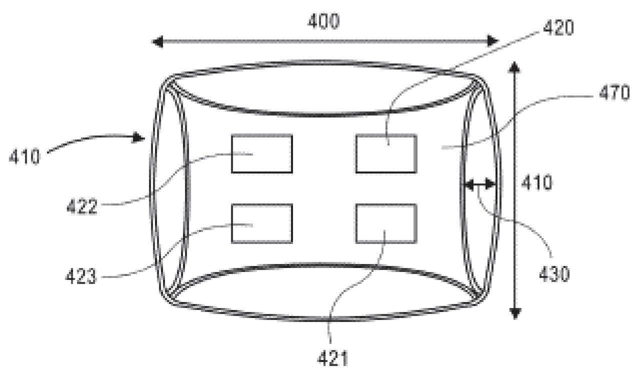

FIG. 4A

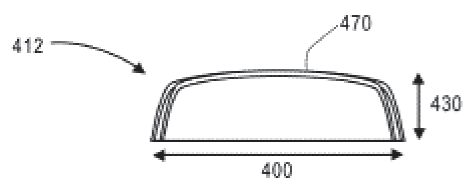

FIG. 4B

Figures 4A and 4B illustrate arrangements of protrusion 405 including measurement contact area 470. *Id.* at 23:30–36. "[M]easurement site contact area 470 can include a surface that molds body tissue of a measurement site." *Id.* "For example, . . . measurement site contact area 470 can be generally curved and/or convex with respect to the measurement site." *Id.* at 23:53–55. The measurement site contact area may include

windows 420–423 that "mimic or approximately mimic a configuration of, or even house, a plurality of detectors." *Id.* at 23:61–24:8.

D. Illustrative Claim

Of the challenged claims, claims 1, 20, and 30 are independent. Claim 1 is illustrative and is reproduced below.

> 1. A physiological measurement system comprising:
>
> [a] a physiological sensor device comprising:
>
> [b] one or more emitters configured to emit light into tissue of a user;
>
> [c] a first set of photodiodes, wherein:
>
> [d] the first set of photodiodes comprises at least four photodiodes,
>
> [e] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream, and
>
> [f] each of the photodiodes of the first set of photodiodes has a corresponding window that allows light to pass through to the photodiode;
>
> [g] a second set of photodiodes, wherein:
>
> [h] the second set of photodiodes comprises at least four photodiodes,
>
> [i] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream, and
>
> [j] each of the photodiodes of the second set of photodiodes has a corresponding window that allows light to pass through to the photodiode;
>
> [k] a wall that surrounds at least the first and second sets of photodiodes; and

[l] a cover comprising a protruding convex surface, wherein the protruding convex surface is above all of the photodiodes of the first and second sets of photodiodes, wherein at least a portion of the protruding convex surface is rigid, and wherein the cover is above the wall; and

[m] a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises:

[n] one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user;

[o] a touch-screen display configured to provide a user interface, wherein:

[p] the user interface is configured to display indicia responsive to measurements of the physiological parameter, and

[q] an orientation of the user interface is configurable responsive to a user input; and

[r] a storage device configured to at least temporarily store at least the measurements of the physiological parameter.

Ex. 1001, 45:2–49 (bracketed identifiers [a]–[r] added). Independent claim 20 includes limitations substantially similar to limitations [a]–[j] and [l]–[m] of claim 1. *Id.* at 47:9–36. Independent claim 30 includes limitations similar to limitations [a]–[r] of claim 1, and also includes additional recitations. *Id.* at 48:38–50:21 (reciting also a "substrate" and certain "preprocessing electronics").

E. Applied References

Petitioner relies upon the following references:

Beyer, Jr., U.S. Patent No. 7,031,728 B2, filed Sept. 21, 2004, issued Apr. 18, 2006 (Ex. 1019, "Beyer");

Ohsaki et al., U.S. Patent Application Publication No. 2001/0056243 A1, filed May 11, 2001, published December 27, 2001 (Ex. 1014, "Ohsaki");

Aizawa, U.S. Patent Application Publication No. 2002/0188210 A1, filed May 23, 2002, published December 12, 2002 (Ex. 1006, "Aizawa");

Y. Mendelson, et al., "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," Proceedings of the 25th IEEE EMBS Annual International Conference, 3016-3019 (2003) (Ex. 1024, "Mendelson-2003"); and

Y. Mendelson et al., "A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring," Proceedings of the 28th IEEE EMBS Annual International Conference, 912–915 (2006) (Ex. 1010, "Mendelson-2006").

Pet. 2. Petitioner also submits, *inter alia*, the Declaration of Thomas W. Kenny, Ph.D. (Ex. 1003).

F. Asserted Grounds

Petitioner asserts that claims 1–30 are unpatentable based upon the following grounds (Pet. 1–2):

Claims Challenged	35 U.S.C. §	References/Basis
1–18, 20, 22–30	103	Aizawa, Mendelson-2003, Ohsaki, Mendelson-2006
19, 21	103	Aizawa, Mendelson-2003, Ohsaki, Mendelson-2006, Beyer

II. DISCUSSION

A. Claim Construction

For petitions filed on or after November 13, 2018, a claim shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R.

§ 42.100(b) (2019). Petitioner submits that no claim term requires express construction. Pet. 3.

Based on our analysis of the issues in dispute at this stage of the proceeding, we agree that no claim terms require express construction at this time. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

B. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103 if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of non-obviousness.[2] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). When evaluating a combination of teachings, we must also "determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue." *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). Whether a combination of prior art elements would have produced a predictable result weighs in the ultimate determination of obviousness. *Id.* at 416–417.

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[2] Patent Owner does not present objective evidence of non-obviousness at this stage.

In an *inter partes* review, the petitioner must show with particularity why each challenged claim is unpatentable. *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016); 37 C.F.R. § 42.104(b). The burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

C. Level of Ordinary Skill in the Art

Petitioner identifies the appropriate level of skill in the art as that possessed by a person having "a Bachelor of Science degree in an academic discipline emphasizing the design of electrical, computer, or software technologies, in combination with training or at least one to two years of related work experience with capture and processing of data or information." Pet. 3 (citing Ex. 1003 ¶¶ 20–21). "Alternatively, the person could have also had a Master of Science degree in a relevant academic discipline with less than a year of related work experience in the same discipline." *Id.*

For purposes of this Decision, we generally adopt Petitioner's assessment as set forth above, which appears consistent with the level of skill reflected in the Specification and prior art.

D. Obviousness over the Combined Teachings of Aizawa, Mendelson-2003, Ohsaki, and Mendelson-2006

Petitioner presents undisputed contentions that claims 1–18, 20, and 22–30 of the '194 patent would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Mendelson-2006. Pet. 7–82.

1. Overview of Aizawa (Ex. 1006)

Aizawa is a U.S. patent application publication titled "Pulse Wave Sensor and Pulse Rate Detector," and discloses a pulse wave sensor that detects light output from a light emitting diode and reflected from a patient's artery. Ex. 1006, codes (54), (57).

Figure 1(a) of Aizawa is reproduced below.

FIG. 1 (a)

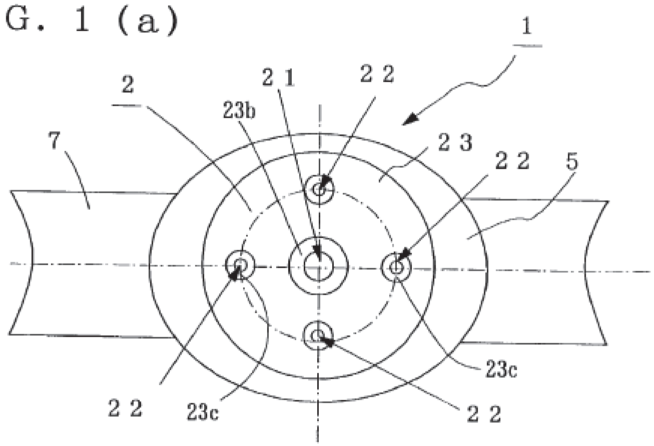


Figure 1(a) is a plan view of a pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(a), pulse wave sensor 2 includes light emitting diode ("LED") 21, four photodetectors 22 symmetrically disposed around LED 21, and holder 23 for storing LED 21 and photodetectors 22. *Id.* Aizawa discloses that, "to further improve detection efficiency, . . . the number of the photodetectors 22 may be increased." *Id.* ¶ 32, Fig. 4(a). "The same effect can be obtained when the number of photodetectors 22 is 1 and a plurality of light emitting diodes 21 are disposed around the photodetector 22." *Id.* ¶ 33.

Figure 1(b) of Aizawa is reproduced below.

FIG. 1 (b)

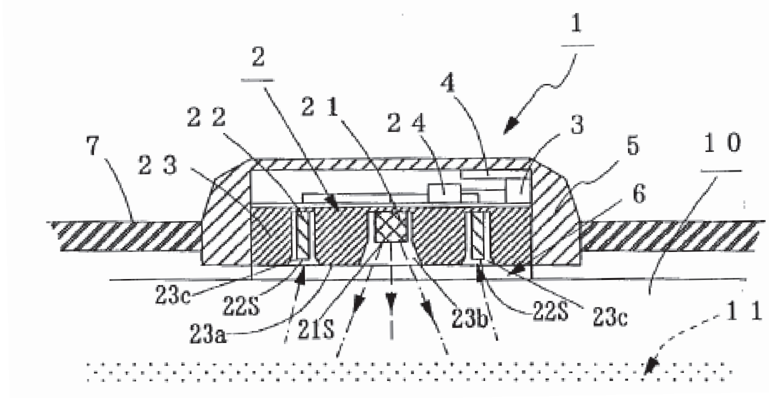


Figure 1(b) is a sectional view of the pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(b), pulse wave sensor 2 includes drive detection circuit 24 for detecting a pulse wave by amplifying the outputs of photodetectors 22. *Id.* ¶ 23. Arithmetic circuit 3 computes a pulse rate from the detected pulse wave and transmitter 4 transmits the pulse rate data to an "unshown display." *Id.* The pulse rate detector further includes outer casing 5 for storing pulse wave sensor 2, acrylic transparent plate 6 mounted to detection face 23a of holder 23, and attachment belt 7. *Id.* ¶ 23.

Aizawa discloses that LED 21 and photodetectors 22 "are stored in cavities 23b and 23c formed in the detection face 23a" of the pulse wave sensor. *Id.* ¶ 24. Detection face 23a "is a contact side between the holder 23 and a wrist 10, respectively, at positions where the light emitting face 21s of the light emitting diode 21 and the light receiving faces 22s of the photodetectors 22 are set back from the above detection face 23a." *Id.* ¶ 24. Aizawa discloses that "a subject carries the above pulse rate detector 1 on the inner side of his/her wrist 10 . . . in such a manner that the light emitting face 21s of the light emitting diode 21 faces down (on the wrist 10 side)." *Id.* ¶ 26. Furthermore, "the above belt 7 is fastened such that the acrylic

transparent plate 6 becomes close to the artery 11 of the wrist 10. Thereby, adhesion between the wrist 10 and the pulse rate detector 1 is improved." *Id.* ¶¶ 26, 34.

2. Overview of Mendelson-2003 (Ex. 1024)

Mendelson-2003 is a journal article titled "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," which discusses a pulse oximeter sensor in which "battery longevity could be extended considerably by employing a wide annularly shaped photodetector ring configuration and performing SpO_2 measurements from the forehead region." Ex. 1024, 3016.[3]

Mendelson-2003 explains that pulse oximetry uses sensors to monitor oxygen saturation (SpO_2), where the sensor typically includes light emitting diodes (LED) and a silicon photodetector (PD). *Id.* According to Mendelson-2003, when designing a pulse oximeter, it is important to offer "low power management without compromising signal quality." *Id.* at 3017. "However, high brightness LEDs commonly used in pulse oximeters require[] relatively high current pulses, typically in the range between 100–200mA. Thus, minimizing the drive currents supplied to the LEDs would contribute considerably toward the overall power saving in the design of a more efficient pulse oximeter." To achieve this goal, Mendelson-2003 discusses previous studies in which

> the driving currents supplied to the LEDs . . . could be lowered significantly without compromising the quality of the

[3] Petitioner cites to the native page numbers appearing at the top of Exhibit 1024, rather than the added page numbering at the bottom of the pages. We follow Petitioner's numbering scheme.

> [photoplethysmographic signal] by increasing the overall size of the PD . . . . Hence, by maximizing the light collected by the sensor, a very low power-consuming sensor could be developed, thereby extending the overall battery life of a pulse oximeter intended for telemedicine applications.

Id.

Mendelson-2003 discloses the prototype of such a sensor in Figure 1, which is reproduced below, and served as the basis for the studies evaluated in Mendelson-2003.

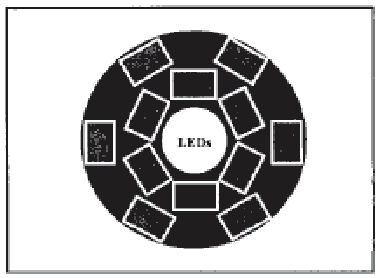


Figure 1 of Mendelson-2003 depicts a sensor configuration showing the relative positions of its PDs and LEDs. *Id.* As shown in Figure l, "six PDs were positioned in a close inner-ring configuration at a radial distance of 6.0mm from the LEDs. The second set of six PDs spaced equally along an outer-ring, separated from the LEDs by a radius of 10.0mm." *Id.* Mendelson-2003 also explains that "[e]ach cluster of six PDs were wired in parallel and connected through a central hub to the common summing input of a current-to-voltage converter." *Id.*

Mendelson-2003 reports the results of the studies as follows:

> Despite the noticeable differences between the PPG signals measured from the wrist and forehead, the data plotted in Fig. 3 also revealed that considerable stronger PPGs could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity. The additional increase, however, depends on the area and relative position of the PD with respect to the LEDs. For example,

> utilizing the outer-ring configuration, the overall increase in the average amplitudes of the R and IR PPGs measured from the forehead region was 23% and 40%, respectively. Similarly, the same increase in PD area produced an increase in the PPG signals measured from the wrist, but with a proportional higher increase of 42% and 73%.

Id. at 3019.

3. Overview of Ohsaki (Ex. 1014)

Ohsaki is a U.S. patent application publication titled "Wristwatch-type Human Pulse Wave Sensor Attached on Back Side of User's Wrist," and discloses an optical sensor for detecting a pulse wave of a human body. Ex. 1014, code (54), ¶ 3. Figure 1 of Ohsaki is reproduced below.

FIG. 1

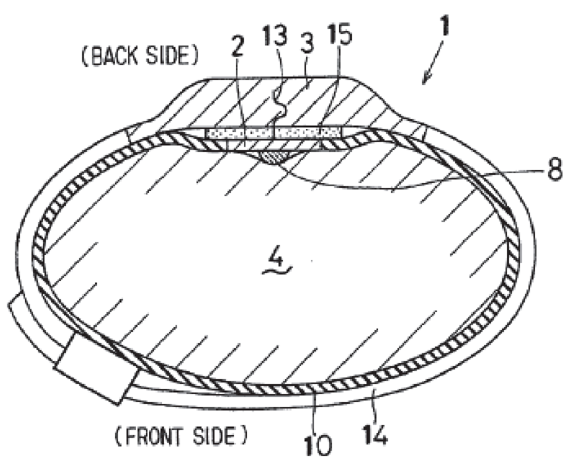


Figure 1 illustrates a cross-sectional view of pulse wave sensor 1 attached on the back side of user's wrist 4. *Id.* ¶¶ 12, 16. Pulse wave sensor 1 includes detecting element 2 and sensor body 3. *Id.* ¶ 16.

Figure 2 of Ohsaki, reproduced below, illustrates further detail of detecting element 2.

FIG. 2

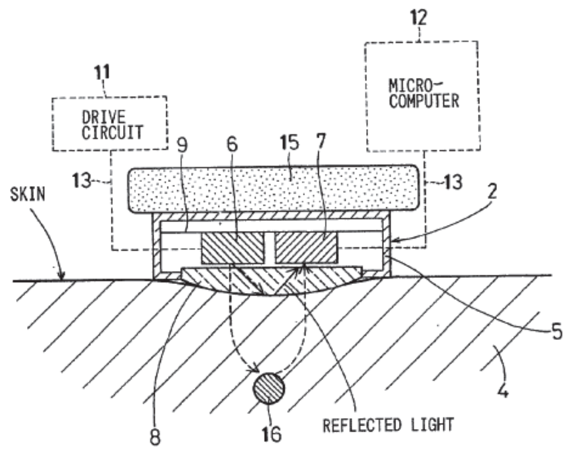


Figure 2 illustrates a mechanism for detecting a pulse wave. *Id.* ¶ 13. Detecting element 2 includes package 5, light emitting element 6, light receiving element 7, and translucent board 8. *Id.* ¶ 17. Light emitting element 6 and light receiving element 7 are arranged on circuit board 9 inside package 5. *Id.* ¶¶ 17, 19.

"[T]ranslucent board 8 is a glass board which is transparent to light, and attached to the opening of the package 5. A convex surface is formed on the top of the translucent board 8." *Id.* ¶ 17. "[T]he convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin," preventing detecting element 2 from slipping off the detecting position of the user's wrist. *Id.* ¶ 25. By preventing the detecting element from moving, the convex surface suppresses "variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin." *Id.* Additionally, the convex surface prevents penetration by "noise such as disturbance light from the outside." *Id.*

Sensor body 3 is connected to detecting element 2 by signal line 13. *Id.* ¶ 20. Signal line 13 connects detecting element 2 to drive circuit 11, microcomputer 12, and a monitor display (not shown). *Id.* Drive circuit 11 drives light emitting element 6 to emit light toward wrist 4. *Id.* Detecting element 2 receives reflected light which is used by microcomputer 12 to calculate pulse rate. *Id.* "The monitor display shows the calculated pulse rate." *Id.*

4. *Mendelson-2006 (Ex. 1016)*

Mendelson-2006 is a journal article titled "A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring," and discloses a wireless wearable pulse oximeter connected to a personal digital assistant ("PDA"). Ex. 1016, 1.[4]

Figure 1 of Mendelson-2006 is reproduced below.

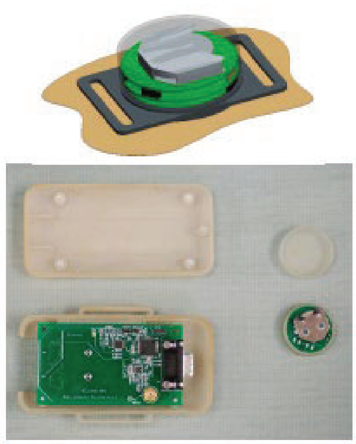


Figure 1 illustrates a sensor module attached to the skin (top), and a photograph of a disassembled sensor module and receiver module (bottom).

[4] Petitioner cites to the page numbers added to Exhibit 1010, rather than the native page numbering that accompanies the article. *See, e.g.*, Pet. 20–22. We follow Petitioner's numbering scheme.

The sensor module includes an optical transducer, a stack of round printed circuit boards, and a coin cell battery. *Id.* at 2.

Figure 2 of Mendelson-2006 is reproduced below.

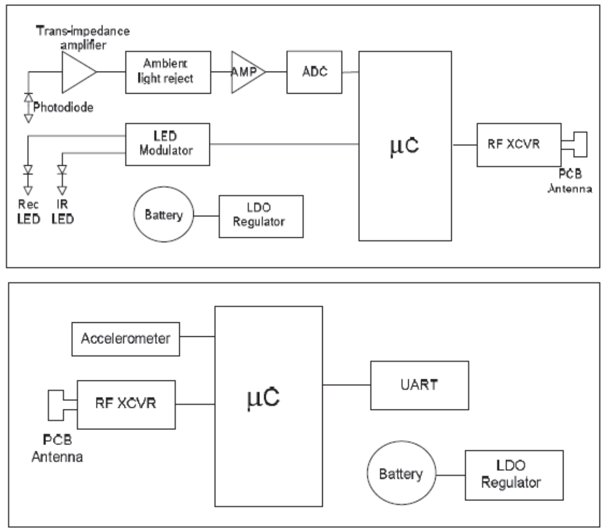


Figure 2 depicts a system block diagram of the wearable, wireless, pulse oximeter including the sensor module (top) and the receiver module (bottom). *Id.* The sensor module includes at least one light-emitting diode ("LED"), a photodetector, signal processing circuitry, an embedded microcontroller, and an RF transceiver. *Id.* at 1–2. Mendelson-2006 discloses that a concentric array of discrete photodetectors could be used to increase the amount of backscattered light detected by a reflectance type pulse oximeter sensor. *Id.* at 4. The receiver module includes an embedded microcontroller, an RF transceiver for communicating with the sensor module, and a wireless module for communicating with the PDA. *Id.* at 2.

As a PDA for use with the system, Mendelson-2006 discloses "the HP iPAQ h4150 PDA because it can support both 802.11b and Bluetooth™ wireless communication" and "has sufficient computational resources." *Id.* at 3. Mendelson further discloses that

> [t]he use of a PDA as a local terminal also provides a low-cost touch screen interface. The user-friendly touch screen of the PDA offers additional flexibility. It enables multiple controls to occupy the same physical space and the controls appear only when needed. Additionally, a touch screen reduces development cost and time, because no external hardware is required. . . . The PDA can also serve to temporarily store vital medical information received from the wearable unit.

Id.

The PDA is shown in Figure 3 of Mendelson-2006, reproduced below.

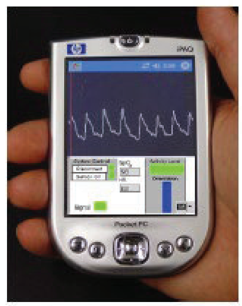


Figure 3 illustrates a sample PDA and its graphical user interface ("GUI"). *Id.* Mendelson-2006 explains that the GUI allows the user to interact with the wearable system. *Id.* "The GUI was configured to present the input and output information to the user and allows easy activation of various functions." *Id.* "The GUI also displays the subject's vital signs, activity level, body orientation, and a scrollable PPG waveform that is transmitted by the wearable device." *Id.* For example, the GUI displays numerical oxygen saturation ("SpO_2") and heart rate ("HR") values. *Id.*

5. *Independent Claim 1*

Petitioner presents undisputed contentions that claim 1 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Mendelson-2006. Pet. 30–54.

i. "A physiological measurement system comprising"

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses a pulse sensor.[5] Pet. 30; *see, e.g.*, Ex. 1006 ¶ 2 (disclosing "a pulse wave sensor for detecting the pulse wave of a subject").

ii. "[a] a physiological sensor device comprising"

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses a physiological sensor device including a pulse rate detector. Pet. 30–31; *see, e.g.*, Ex. 1006 ¶ 23 (pulse wave sensor 2), Figs. 1(a)–(b) (depicting pulse wave sensor 2), Fig. 2 (depicting sensor worn on user's wrist.

iii. "[b] one or more emitters configured to emit light into tissue of a user"

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses LED 21 that emits light into a user's tissue. Pet. 31; *see, e.g.*, Ex. 1006 ¶ 23 ("LED 21 . . . for emitting light having a wavelength of a near infrared range"), Fig. 1(b) (depicting emitter 21 facing user tissue 10).

iv. "[c] a first set of photodiodes, wherein: [d] the first set of photodiodes comprises at least four photodiodes" and "[g] a second set of photodiodes, wherein: [h] the

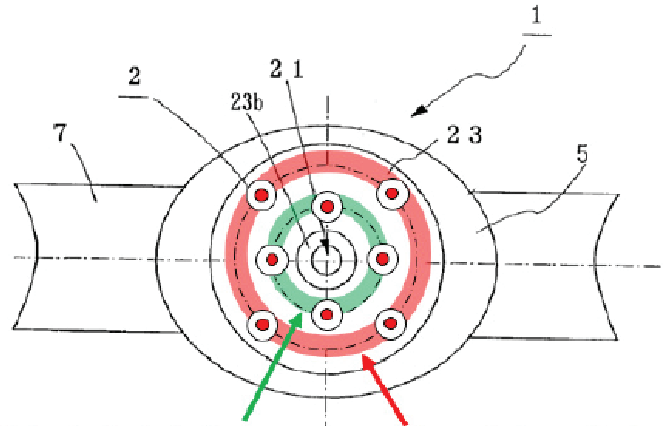
[5] Whether the preamble is limiting need not be resolved at this stage of the proceeding because Petitioner shows sufficiently for purposes of institution that the recitation in the preamble is satisfied by the prior art.

second set of photodiodes comprises at least four photodiodes"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 16–22, 32–40, 40–42. Specifically, Petitioner contends that Aizawa discloses a first set of four photodiodes that are circularly arranged around a central emitter. *Id.* at 16; *see, e.g.*, Ex. 1006 ¶ 23 ("four phototransistors 22"), Figs. 1(a)–1(b) (depicting detectors 22 surrounding LED 21). Petitioner contends that Aizawa teaches that eight or more detectors may be used to improve detection efficiency, but does not expressly teach a "second set of photodiodes," as claimed. Pet. 17; *see, e.g.*, Ex. 1006 ¶ 32 ("the number of the photodetectors 22 may be increased"), Fig. 4(a).

According to Petitioner, Mendelson-2003 teaches two rings of photodiodes, which improve light collection efficiency, permit use of lower brightness LEDs, and reduce power consumption. Pet. 18–19; *see, e.g.*, Ex. 1024, 3017 ("[S]ix PDs [(photodetectors)] were positioned in a close inner-ring configuration . . . The second set of six PDs [were] spaced equally along an outer-ring."), 3019 (explaining that "considerabl[y] stronger [photoplethysmographic signals] could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity").

In view of these teachings, Petitioner contends, with reference to the modified and annotated figures reproduced below, that a person of ordinary skill in the art would have found it obvious to modify Aizawa to include an additional ring of detectors (a "second set") to "advance[e] Aizawa's goal of improving detection efficiency through increased power savings as taught by Mendelson-2003." Pet. 17–21, 32; *see, e.g.*, Ex. 1003 ¶¶ 68, 71–73.



Petitioner's modified and annotated figure depicts Aizawa's sensor with Aizawa's first set of photodiodes (depicted as connected by a green ring) and modified to include a second set of photodiodes as taught by Mendelson-2003 (depicted as connected by a red ring). Pet. 20–21, 33, 41. Petitioner contends this would have been the use of a known solution to improve similar systems in the same way. *Id.* at 21; Ex. 1003 ¶ 74.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 66–74, 90–91, 100–101.

v. "[e] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream"
and
"[i] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream"

On this record, the cited evidence supports Petitioner's undisputed contention that Mendelson-2003 discloses that each set of photodiodes are connected in parallel to provide signal streams. Pet. 34–35; Ex. 1024, 3017 ("Each cluster of six PDs were wired in parallel and connected through a

central hub to the common summing input of a current-to-voltage converter."); *see also* Pet. 33–38 (additional contentions); Ex. 1003 ¶¶ 92–97, 102.

vi. "[f] each of the photodiodes of the first set of photodiodes has a corresponding window that allows light to pass through to the photodiode" and "[j] each of the photodiodes of the second set of photodiodes has a corresponding window that allows light to pass through to the photodiode"

On this record, the cited evidence supports Petitioner's undisputed contentions that Aizawa teaches windows, i.e., "tapered cavities that provide an opening for each of the detectors (e.g., each of the photodiodes of the first set of photodiodes) and that serve to increase, for instance, the concentration of light collected by the detectors, thereby increasing the signal to noise ratio," and that a person of ordinary skill in the art would have provided such windows for the second set of photodiodes, suggested by the combination with Mendelson-2003. Pet. 38–40, 42; *see, e.g.*, Ex. 1006 ¶¶ 23 ("four phototransistors 22"), 24 ("stored in cavities" and "set back from . . . detection face 23a"), Figs. 1(a)–1(b) (depicting cavities 23c housing detectors 22); Ex. 1003 ¶¶ 98–99, 103.

vii. "[k] a wall that surrounds at least the first and second sets of photodiodes"

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses holder 23, which includes a wall that surrounds the photodetectors, as well as other elements. Pet. 42–44; *see, e.g.*, Ex. 1006 ¶ 23 ("holder 23 for storing . . . light emitting diode 21 and the

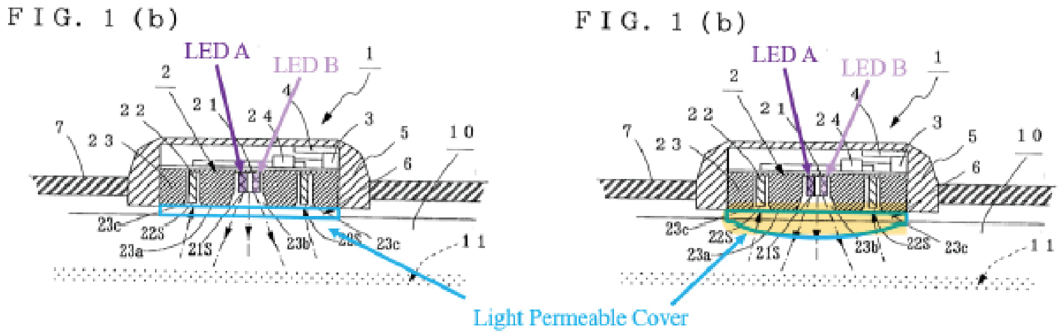
photodetectors 22"), Fig. 1(b) (depicting holder 23 surrounding the detector).

viii. "[l] a cover comprising a protruding convex surface, wherein the protruding convex surface is above all of the photodiodes of the first and second sets of photodiodes, wherein at least a portion of the protruding convex surface is rigid, and wherein the cover is above the wall"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 22–28, 44–47. Specifically, Petitioner contends that Aizawa "teaches a light permeable cover in the form of an acrylic transparent plate 6 . . . that is mounted at the detection face 23a" of the sensor, i.e., above Aizawa's photodetectors. *Id.* at 9–10; Ex. 1006 ¶ 34 ("[A]crylic transparent plate 6 is provided on the detection face 23a of the holder 23 to improve adhesion to the wrist 10."), Fig. 1(b) (depicting flat, transparent plate 6 between sensor 2 and wrist 10). Petitioner also contends that Ohsaki teaches a wrist-worn sensor that includes a "translucent board" having a convex surface that contacts the user's skin to prevent slippage of the sensor. Pet. 12–13, 22–23; *see, e.g.*, Ex. 1014 ¶¶ 16 ("worn on the back side of the user's wrist"), 17 ("convex surface"), 25 ("intimate contact" prevents slippage), Figs. 1–2 (depicting convex translucent board 8 between tissue and detector). Petitioner also contends that Ohsaki's Figure 2 depicts the user's tissue conforming to the shape of the convex surface of the cover, such that the convex surface would have been understood to be rigid. Pet. 46–47; *see, e.g.*, Ex. 1003 ¶¶ 107–108.

Petitioner further contends, with reference to the modified and annotated figures reproduced below, that a person of ordinary skill in the art "would have found it obvious to modify [Aizawa's] sensor's flat cover (left)

to include a lens/protrusion (right), similar to Ohsaki's translucent board 8, so as to improve adhesion between the user's wrist and the sensor's surface, improve detection efficiency, and protect the elements within the sensor housing." Pet. 24–25, 44–45 (similar); Ex. 1003 ¶¶ 75, 78–79, 82–83, 105.



Petitioner's modified and annotated figures depict Aizawa's sensor as shown in Figure 1(b), modified to include a convex cover. *Id.* at 24–25, 44–45; *see, e.g.*, Ex. 1014 ¶¶ 18 (explaining that outside disturbance light is prevented from penetrating the translucent board because "the surface of the translucent board 8 is in intimate contact with the surface of the user's skin"), 25 ("[T]he convex surface . . . is in intimate contact with the surface of the user's skin. Thereby it is prevented that the detecting element 2 slips off the detecting position of the user's wrist . . . . [Due to the] convex surface . . . the variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin is suppressed [and] [i]t is also prevented that noise such as disturbance light from the outside penetrates the translucent board 8. Therefore the pulse wave can be detected without being affected."); Ex. 1003 ¶¶ 75, 78–79, 82–83, 105. Petitioner contends that, in the combination, the cover is "above" the wall provided by holder 23. Pet. 45.

Petitioner also contends that combining these teachings "would have amounted to nothing more than the use of a known technique to improve similar devices in the same way." Pet. 25; *see, e.g.*, Ex. 1003 ¶ 79. Petitioner contends that "the elements of the combined system would each perform similar functions they had been known to perform prior to the combination—Aizawa-Mendelson-2003's transparent plate 6 would remain in the same position, performing the same function, but with a convex surface as taught by Ohsaki." Pet. 25–26.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 75–83, 105–108.

ix. "[m] a handheld computing device in wireless communication with the physiological sensor device, wherein the handheld computing device comprises"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 28–29, 47–49. Specifically, Petitioner contends the combination of, *inter alia*, Aizawa and Mendelson-2006 teaches that Aizawa's sensor device is in wireless communication with Mendelson-2006's body worn receiver module and PDA. *Id.* at 47;[6] *see,*

[6] At pages 47–48, the Petitioner refers to "Mendelson-2003" when discussing the receiver module and PDA. *See, e.g.*, Pet. 47 (contending that the modified system "includes Aizawa's wrist-worn sensor device that is in communication with Mendelson-2003's body-worn receiver module (below left) and PDA (below right)"). The cited disclosures, however, appear in Mendelson-2006, as Petitioner's citations confirm. *Id.* at 47–48 (citing Ex. 1016). Therefore, it appears these references to "Mendelson-2003" are inadvertent typographical errors, and that "Mendelson-2006" was intended. *See also id.* at 28–29 (referring to Mendelson-2006's receiver module and PDA).

e.g., Ex. 1016, 1–2 (describing system), Fig. 1 (sensor attached to skin), Fig. 3 (PDA). Petitioner contends that a person of ordinary skill in the art would have "found it obvious and straightforward to further modify Aizawa-Mendelson-2003-Ohsaki in view of Mendelson-2006 to yield a pulse detector that can transmit data to an external device—i.e., handheld computing device—for monitoring" and "to enable a convenient and user-friendly interface with Aizawa's detector (which does not include a separate display/interface) and the ability to remotely monitor the user's physiological parameters." Pet. 28–29; *see, e.g.*, Ex. 1003 ¶¶ 85–86.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 84–86, 109–111.

x. "[n] one or more processors configured to wirelessly receive one or more signals from the physiological sensor device, the one or more signals responsive to at least a physiological parameter of the user"

On this record, the cited evidence supports Petitioner's undisputed contention that Mendelson-2006's receiver includes a microcontroller (processor) that wirelessly receives signals from Aizawa's sensor and transmits them to the PDA. Pet. 50; *see, e.g.*, Ex. 1016, 1, 2 ("The information acquired by the Sensor Module is transmitted wirelessly via an RF link over a short range to a body-worn Receiver Module. The data processed by the Receiver Module can be transmitted wirelessly to a PDA."), 3 (explaining that the PDA "has sufficient computational resources for the intended application" and "can also serve to temporarily store vital medical information received from the wearable unit"), Fig. 3 (displaying SpO_2 and HR data); Ex. 1003 ¶ 112.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. Ex. 1003 ¶¶ 112–113.

xi. "[o] a touch-screen display configured to provide a user interface, wherein: [p] the user interface is configured to display indicia responsive to measurements of the physiological parameter, and [q] an orientation of the user interface is configurable responsive to a user input"

On this record, the cited evidence supports Petitioner's undisputed contention that Mendelson-2006 describes a PDA with a touchscreen display configured to display indicia responsive to measurements of, e.g., SpO_2 and HR. Pet. 51–52; *see, e.g.*, Ex. 1016, 3 ("The use of a PDA . . . also provides a low-cost touch screen interface."), Fig. 3 (displaying SpO_2 and HR data).

Petitioner acknowledges that "Mendelson-2006 does not explicitly state that an orientation of the GUI provided by the PDA is configurable responsive to a user input." Pet. 52. However, Petitioner contends that a person of ordinary skill in the art would have understood that the "'LabVIEW program' . . . [and] the 'Windows CE™' operating system" would have "enabled users to dynamically switch the screen orientation between portrait and landscape modes." *Id.* at 53; *see, e.g.*, Ex. 1003 ¶¶ 116–118.

Petitioner further contends that, in light of these teachings, a person of ordinary skill in the art "would have found it obvious to make an orientation of the PDA's user interface configurable responsive to a user input, for the sake of user convenience." Pet. 53; *see, e.g.*, Ex. 1003 ¶ 118.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 114–118.

xii. "[r] a storage device configured to at least temporarily store at least the measurements of the physiological parameter."

On this record, the cited evidence supports Petitioner's undisputed contention that Mendelson-2006 teaches that the PDA is configured to store vital medical information received from the wearable pulse oximeter, and that an ordinarily skilled artisan "would have understood that the vital medical information would have included measurements of the physiological parameters obtained by the physiological sensor device (e.g., HR)." Pet. 54; Ex. 1016, 3 ("The PDA can also serve to temporarily store vital medical information received from the wearable unit."); Ex. 1003 ¶ 120. Thus, Petitioner contends that a person of ordinary skill in the art "would have configured a storage device of the PDA to at least temporarily store measurements of physiological parameters (e.g., HR)." Pet. 53; *see, e.g.*, Ex. 1003 ¶ 119.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 119–120.

xiii. Summary

For the foregoing reasons, we are persuaded that Petitioner's cited evidence and reasoning demonstrates a reasonable likelihood that Petitioner would prevail in its contentions regarding claim 1.

6. Independent Claim 20

Independent claim 20 consists of limitations that are substantially similar to elements [a]–[j] and [l]–[m] of claim 1. *Compare* Ex. 1001, 45:2–49, *with id.* at 47:9–36. In asserting that claim 20 also would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Mendelson-2006, Petitioner refers to the same arguments presented as to claim 1. *See* Pet. 75–76; Ex. 1003 ¶¶ 155–161. For the same reasons discussed above, we are persuaded that Petitioner's cited evidence and reasoning demonstrates a reasonable likelihood that Petitioner would prevail in its contentions regarding claim 20. *See supra* II.D.5.i–v, vii–viii.

7. Claims 2–18 and 22–30

Petitioner presents undisputed contentions that independent claim 30, and dependent claims 2–18 and 22–29, which depend directly or indirectly from independent claim 1 or 20, are unpatentable over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Mendelson-2006, and provides arguments explaining how the references teach the limitations of these claims. Pet. 54–75, 76–82; Ex. 1003 ¶¶ 121–154, 162–208. Patent Owner does not offer, at this stage, any arguments addressing Petitioner's substantive showing. PO Waiver. We have reviewed these arguments and the cited evidence, and we determine Petitioner has demonstrated a reasonable likelihood of prevailing as to these contentions.

Moreover, as discussed in detail above, Petitioner has demonstrated a reasonable likelihood of prevailing on the challenge to claims 1 and 20. Therefore, pursuant to USPTO policy implementing the decision in *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348 (2018) ("*SAS*"), we institute as to all claims challenged in the petition and on all grounds in the petition. *See*

PTAB Consolidated Trial Practice Guide (Nov. 2019) ("Consolidated Guide"),[7] 5–6, 64.

E. Additional Ground

Petitioner provides arguments and evidence, including the Kenny Declaration, in support of Petitioner's additional ground challenging dependent claim 19 and 21 of the '194 patent. Pet. 82–85; Ex. 1003 ¶¶ 209–212. Patent Owner does not offer, at this stage, any arguments addressing Petitioner's substantive showing. PO Waiver. We have reviewed these arguments and the cited evidence, and we determine Petitioner has demonstrated a reasonable likelihood of prevailing as to these contentions. We institute review of all of these challenges. *See SAS*; Consolidated Practice Guide, 5–6, 64.

III. CONCLUSION

The Supreme Court held that a final written decision under 35 U.S.C. § 318(a) must decide the patentability of all claims challenged in the petition. *See SAS*, 138 S. Ct. 1348. After considering the evidence and arguments presented in the Petition, we determine that Petitioner has demonstrated a reasonable likelihood of success in proving that at least claims 1 and 20 of the '194 patent are unpatentable. Accordingly, we institute an *inter partes* review of all claims and all grounds set forth in the Petition.[8]

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[7] Available at https://www.uspto.gov/TrialPracticeGuideConsolidated.

[8] The Petition addresses the Board's discretion under 35 U.S.C. §§ 314(a) and 325(d). *See* Pet. 85–90. Patent Owner does not argue that we should exercise discretion to deny institution of *inter partes* review. *See* PO Waiver. Accordingly, we do not consider exercising discretion to deny

At this stage of the proceeding, we have not made a final determination as to the patentability of any challenged claim or as to the construction of any claim term.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 1–30 of the ’194 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the ’194 patent shall commence on the entry date of this Order, and notice is hereby given of the institution of a trial.

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institution of *inter partes* review under 35 U.S.C. §§ 314(a) and 325(d) any further.

Case: 22-1972 Document: 31 Page: 167 Filed: 05/01/2023

FOR PETITIONER:

W. Karl Renner
Roberto Devoto
Hyun Jin In
FISH & RICHARDSON P.C.
IPR50095-0013IP2@fr.com
devoto@fr.com
axf-ptab@fr.com
in@fr.com

FOR PATENT OWNER:

Joseph R. Re
Stephen W. Larson
Jarom D. Kesler
Jacob L. Peterson
KNOBBE, MARTENS, OLSON, & BEAR, LLP
AppleIPR2020-1538-554@knobbe.com
2jrr@knobbe.com
2swl@knobbe.com
2jzk@knobbe.com
2jup@knobbe.com

Trials@uspto.gov
571-272-7822

Paper 7
Entered: May 5, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

MASIMO CORPORATION,
Patent Owner.

IPR2020-01733
Patent 10,702,195 B1

Before JOSIAH C. COCKS, ROBERT L. KINDER, and AMANDA F. WIEKER, *Administrative Patent Judges.*

WIEKER, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314, 37 C.F.R. § 42.4

I. INTRODUCTION

A. Background

Apple Inc. ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1–17 ("challenged claims") of U.S. Patent No. 10,702,195 B1 (Ex. 1001, "the '195 patent"). Paper 2 ("Pet."). Masimo Corporation ("Patent Owner") waived filing a preliminary response. Paper 6 ("PO Waiver").

We have authority to determine whether to institute an *inter partes* review, under 35 U.S.C. § 314 and 37 C.F.R. § 42.4. An *inter partes* review may not be instituted unless it is determined that "the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314 (2018); *see also* 37 C.F.R. § 42.4(a) ("The Board institutes the trial on behalf of the Director.").

For the reasons provided below and based on the record before us, we determine that Petitioner has demonstrated a reasonable likelihood that Petitioner would prevail in showing the unpatentability of at least one of the challenged claims. Accordingly, we institute an *inter partes* review on all grounds set forth in the Petition.

B. Related Matters

The parties identify the following matters related to the '195 patent:

Masimo Corporation v. Apple Inc., Civil Action No. 8:20-cv-00048 (C.D. Cal.);

Apple Inc. v. Masimo Corporation, IPR2020-01520 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,258,265 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01521 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,292,628 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01523 (PTAB Sept. 9, 2020) (challenging claims of U.S. Patent No. 8,457,703 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01524 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,433,776 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01526 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 6,771,994 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01536 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01537 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01538 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01539 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01713 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,624,564 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01714 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01715 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01716 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,194 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01722 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01723 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2); and

Apple Inc. v. Masimo Corporation, IPR2020-01737 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,709,366 B1).

Pet. 95–96; Paper 3, 3–4.

Patent Owner further identifies the following pending patent applications, among other issued and abandoned applications, that claim priority to, or share a priority claim with, the ’195 patent:

U.S. Patent Application No. 16/834,538;

U.S. Patent Application No. 16/449,143; and

U.S. Patent Application No. 16/805,605.

Paper 3, 1–2.

C. The ’195 Patent

The ’195 patent is titled “Multi-Stream Data Collection System for Noninvasive Measurement of Blood Constituents,” and issued on July 7, 2020, from U.S. Patent Application No. 16/834,467, filed March 30, 2020. Ex. 1001, codes (21), (22), (45), (54). The ’195 patent claims priority through a series of continuation and continuation-in-part applications to Provisional Application Nos. 61/078,228 and 61/078,207, both filed July 3, 2008.[1] *Id.* at codes (60), (63).

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[1] The Office has made the prior determination that the application leading to the ’195 patent should be examined under the pre-AIA first to invent provisions. *See* Ex. 1002, 199 (Apr. 10, 2020, Decision Granting Request

The ’195 patent discloses a two-part data collection system including a noninvasive sensor that communicates with a patient monitor. *Id.* at 2:49–51. The sensor includes a sensor housing, an optical source, and several photodetectors, and is used to measure a blood constituent or analyte, e.g., oxygen or glucose. *Id.* at 2:40–46, 3:8–9. The patient monitor includes a display and a network interface for communicating with a handheld computing device. *Id.* at 2:56–59.

Figure 1 of the ’195 patent is reproduced below.

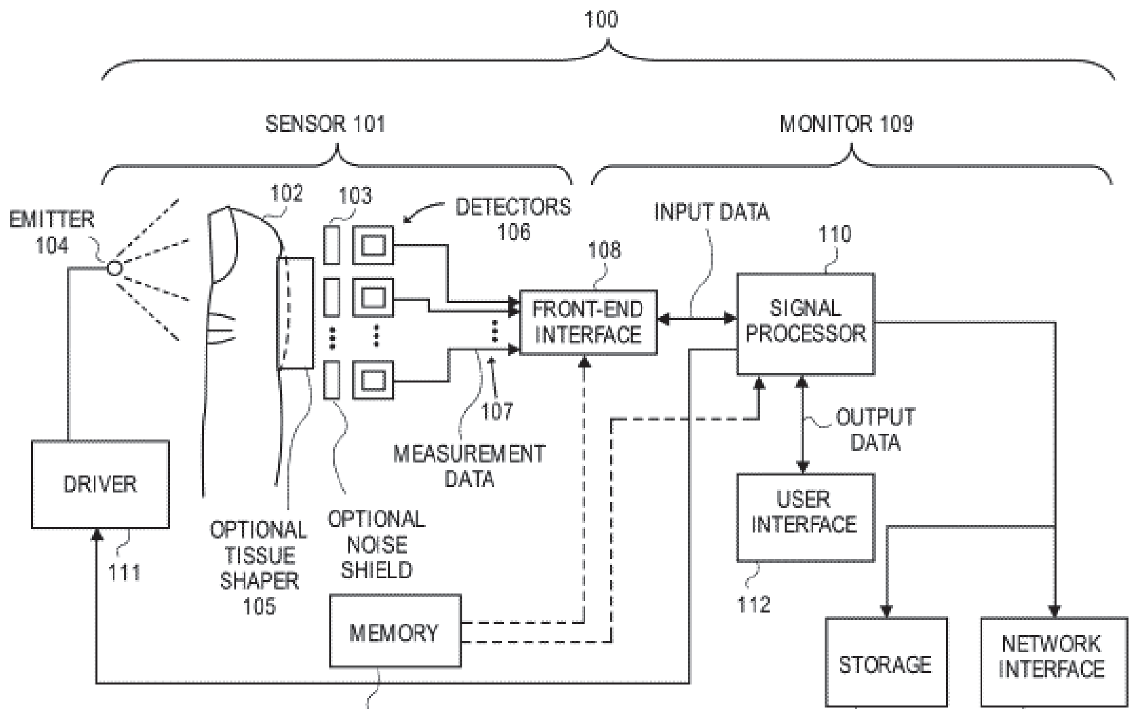

FIG. 1

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for Prioritized Examination listing “AIA (FITF) Status” as “No”). We determine that based on this prior determination, and the lack of any contrary evidence before us, the Petition was not required to be filed more than nine months after the date of the grant of the patent. *See* 37 C.F.R. § 42.102(a)(1). Instead, based on the record before us, 37 C.F.R. § 42.102(a)(2) should apply, which allows a petition to be filed after “the date of the grant of the patent.”

Figure 1 illustrates a block diagram of data collection system 100 including sensor 101 and monitor 109. *Id.* at 11:56–67. Sensor 101 includes optical emitter 104 and detectors 106. *Id.* at 12:1–5. Emitters 104 emit light that is attenuated or reflected by the patient's tissue at measurement site 102. *Id.* at 14:11–16. Detectors 106 capture and measure the light attenuated or reflected from the tissue. *Id.* In response to the measured light, detectors 106 output detector signals 107 to monitor 109 through front-end interface 108. *Id.* at 14:16–19, 36–42. Sensor 101 also may include tissue shaper 105, which may be in the form of a convex surface that: (1) reduces the thickness of the patient's measurement site; and (2) provides more surface area from which light can be detected. *Id.* at 11:7–23.

Monitor 109 includes signal processor 110 and user interface 112. *Id.* at 15:27–29. "[S]ignal processor 110 includes processing logic that determines measurements for desired analytes . . . based on the signals received from the detectors." *Id.* at 15:32–35. User interface 112 presents the measurements to a user on a display, e.g., a touch-screen display. *Id.* at 15:57–67. The monitor may be connected to storage device 114 and network interface 116. *Id.* at 16:4–22.

The '195 patent describes various examples of sensor devices. Figures 14D and 14F, reproduced below, illustrate sensor devices.

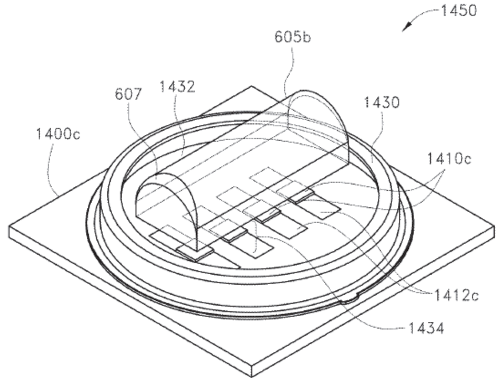


FIG. 14D

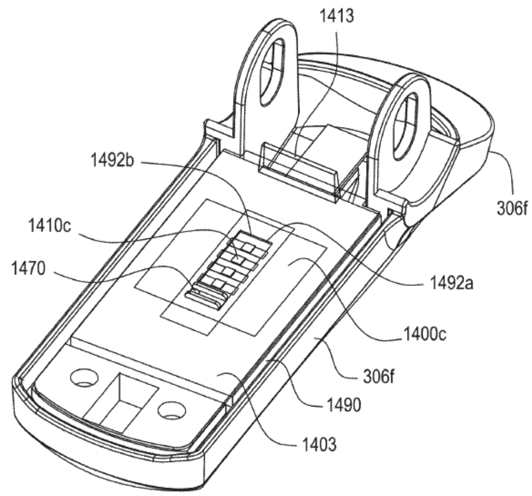


FIG. 14F

Figure 14D illustrates portions of a detector submount and Figure 14F illustrates portions of a detector shell. *Id.* at 6:54–57. As shown in Figure 14D, multiple detectors 1410c are located within housing 1430 and under transparent cover 1432, on which protrusion 605b (or partially cylindrical protrusion 605) is disposed. *Id.* at 35:51–54, 36:45–52. Figure 14F illustrates a detector shell 306f including detectors 1410c on substrate 1400c. *Id.* at 37:25–33. Substrate 1400c is enclosed by shielding enclosure 1490 and noise shield 1403, which include window 1492a and window 1492b, respectively, placed above detectors 1410c. *Id.* Alternatively, cylindrical housing 1430 may be disposed under noise shield 1403 and may enclose detectors 1410c. *Id.* at 37:63–65.

Figures 4A and 4B, reproduced below, illustrate an alternative example of a tissue contact area of a sensor device.

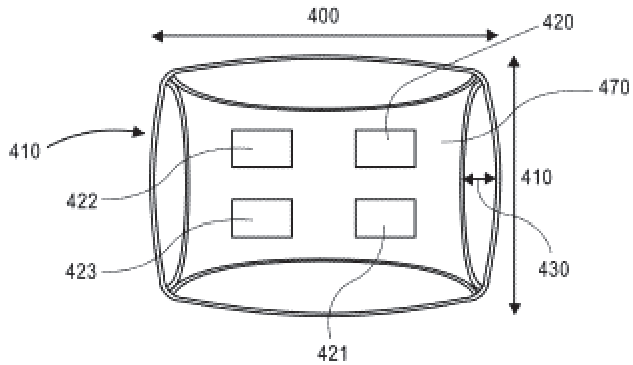


FIG. 4A

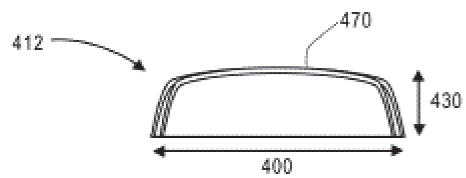


FIG. 4B

Figures 4A and 4B illustrate arrangements of protrusion 405 including measurement contact area 470. *Id.* at 23:30–36. “[M]easurement site contact area 470 can include a surface that molds body tissue of a measurement site.” *Id.* “For example, . . . measurement site contact area 470 can be generally curved and/or convex with respect to the measurement site.” *Id.* at 23:53–55. The measurement site contact area may include windows 420–423 that “mimic or approximately mimic a configuration of, or even house, a plurality of detectors.” *Id.* at 23:61–24:8.

D. Illustrative Claim

Of the challenged claims, claims 1 and 16 are independent. Claim 1 is illustrative and is reproduced below.

> 1. A user-worn physiological measurement device that defines a plurality of optical paths, the physiological measurement device comprising:
>
> [a] one or more emitters configured to emit light into tissue of a user;
>
> [b] a first set of photodiodes positioned on a first surface and surrounded by a wall that is operably connected to the first surface, wherein:
>
>> [c] the first set of photodiodes comprises at least four photodiodes, and

[d] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream;

[e] a second set of photodiodes positioned on the first surface and surrounded by the wall, wherein:

[f] the second set of photodiodes comprises at least four photodiodes, and

[g] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream; and

[h] a cover located above the wall and comprising a single protruding convex surface configured to be located between tissue of the user and the first and second sets of photodiodes when the physiological measurement device is worn by the user,

[i] wherein the physiological measurement device provides a plurality of optical paths, wherein each of the optical paths:

[j] exits an emitter of the one or more emitters,

[k] passes through tissue of the user,

[l] passes through the single protruding convex surface, and

[m] arrives at a corresponding photodiode of the at least one of the first or second sets of photodiodes, the corresponding photodiode configured to receive light emitted by the emitter after traversal by the light of a corresponding optical path of the plurality of optical paths and after attenuation of the light by tissue of the user.

Ex. 1001, 44:63–45:34 (bracketed identifiers [a]–[m] added). Independent claim 16 includes limitations substantially similar to limitations [a]–[h] and includes additional limitations drawn to “a plurality of windows,” “preprocessing electronics,” “one or more processors,” a “network

interface," a "touch-screen display," and "storage device," a "strap," and "a plurality of optical paths." *Id.* at 46:63–48:39.

E. Applied References

Petitioner relies upon the following references:

Ali et al., U.S. Patent No. 6,584,336 B1, filed March 1, 2000, issued June 24, 2003 (Ex. 1046, "Ali");

Ohsaki et al., U.S. Patent Application Publication No. 2001/0056243 A1, filed May 11, 2001, published December 27, 2001 (Ex. 1014, "Ohsaki");

Aizawa, U.S. Patent Application Publication No. 2002/0188210 A1, filed May 23, 2002, published December 12, 2002 (Ex. 1006, "Aizawa");

Goldsmith et al., U.S. Patent Application Publication No. 2007/0093786 A1, filed July 31, 2006, published April 26, 2007 (Ex. 1027, "Goldsmith); and

Y. Mendelson, et al., "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," Proceedings of the 25th IEEE EMBS Annual International Conference, 3016-3019 (2003) (Ex. 1024, "Mendelson-2003").

Pet. 1–2. Petitioner also submits, *inter alia*, the Declaration of Thomas W. Kenny, Ph.D. (Ex. 1003).

F. Asserted Grounds

Petitioner asserts that claims 1–17 are unpatentable based upon the following grounds (Pet. 1–2):

Claims Challenged	35 U.S.C. §	References/Basis
1–17	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith
1–17	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith, Ali

II. DISCUSSION

A. Claim Construction

For petitions filed on or after November 13, 2018, a claim shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b) (2019). Petitioner submits that no claim term requires express construction. Pet. 3.

Based on our analysis of the issues in dispute at this stage of the proceeding, we agree that no claim terms require express construction at this time. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

B. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103 if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of non-obviousness.[2] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). When evaluating a combination of teachings, we must also "determine whether

[2] Patent Owner does not present objective evidence of non-obviousness at this stage.

there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue." *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). Whether a combination of prior art elements would have produced a predictable result weighs in the ultimate determination of obviousness. *Id.* at 416–417.

In an *inter partes* review, the petitioner must show with particularity why each challenged claim is unpatentable. *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016); 37 C.F.R. § 42.104(b). The burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

C. Level of Ordinary Skill in the Art

Petitioner identifies the appropriate level of skill in the art as that possessed by a person having "a Bachelor of Science degree in an academic discipline emphasizing the design of electrical, computer, or software technologies, in combination with training or at least one to two years of related work experience with capture and processing of data or information." Pet. 3 (citing Ex. 1003 ¶¶ 21–22). "Alternatively, the person could have also had a Master of Science degree in a relevant academic discipline with less than a year of related work experience in the same discipline." *Id.*

For purposes of this Decision, we generally adopt Petitioner's assessment as set forth above, which appears consistent with the level of skill reflected in the Specification and prior art.

D. Obviousness over the Combined Teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith

Petitioner presents undisputed contentions that claims 1–17 of the ’195 patent would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith. Pet. 6–85.

1. Overview of Aizawa (Ex. 1006)

Aizawa is a U.S. patent application publication titled “Pulse Wave Sensor and Pulse Rate Detector,” and discloses a pulse wave sensor that detects light output from a light emitting diode and reflected from a patient’s artery. Ex. 1006, codes (54), (57).

Figure 1(a) of Aizawa is reproduced below.

FIG. 1 (a)

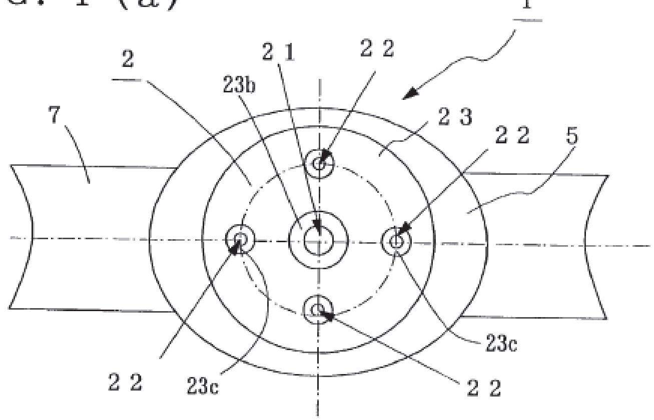


Figure 1(a) is a plan view of a pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(a), pulse wave sensor 2 includes light emitting diode (“LED”) 21, four photodetectors 22 symmetrically disposed around LED 21, and holder 23 for storing LED 21 and photodetectors 22. *Id.* Aizawa discloses that, “to further improve detection efficiency, . . . the number of the photodetectors 22 may be increased.” *Id.* ¶ 32, Fig. 4(a). “The same effect can be obtained when the number of photodetectors 22 is 1 and a plurality of light emitting diodes 21 are disposed around the photodetector 22.” *Id.* ¶ 33.

Figure 1(b) of Aizawa is reproduced below.

FIG. 1 (b)

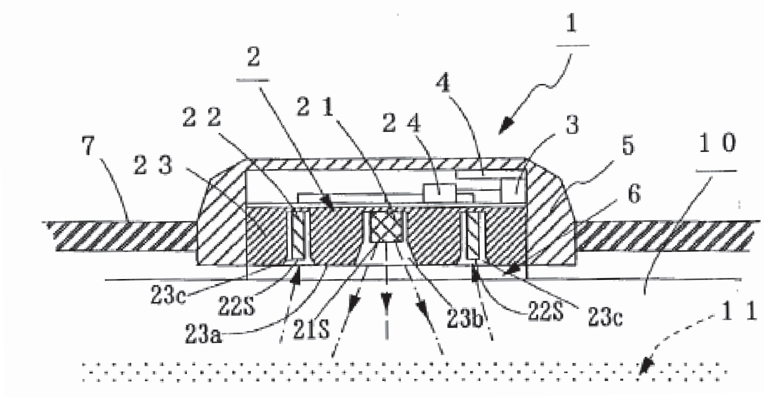


Figure 1(b) is a sectional view of the pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(b), pulse wave sensor 2 includes drive detection circuit 24 for detecting a pulse wave by amplifying the outputs of photodetectors 22. *Id.* ¶ 23. Arithmetic circuit 3 computes a pulse rate from the detected pulse wave and transmitter 4 transmits the pulse rate data to an "unshown display." *Id.* The pulse rate detector further includes outer casing 5 for storing pulse wave sensor 2, acrylic transparent plate 6 mounted to detection face 23a of holder 23, and attachment belt 7. *Id.* ¶ 23.

Aizawa discloses that LED 21 and photodetectors 22 "are stored in cavities 23b and 23c formed in the detection face 23a" of the pulse wave sensor. *Id.* ¶ 24. Detection face 23a "is a contact side between the holder 23 and a wrist 10, respectively, at positions where the light emitting face 21s of the light emitting diode 21 and the light receiving faces 22s of the photodetectors 22 are set back from the above detection face 23a." *Id.* ¶ 24. Aizawa discloses that "a subject carries the above pulse rate detector 1 on the inner side of his/her wrist 10 . . . in such a manner that the light emitting face 21s of the light emitting diode 21 faces down (on the wrist 10 side)." *Id.* ¶ 26. Furthermore, "the above belt 7 is fastened such that the acrylic

transparent plate 6 becomes close to the artery 11 of the wrist 10. Thereby, adhesion between the wrist 10 and the pulse rate detector 1 is improved." *Id.* ¶¶ 26, 34.

2. Overview of Mendelson-2003 (Ex. 1024)

Mendelson-2003 is a journal article titled "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," which discusses a pulse oximeter sensor in which "battery longevity could be extended considerably by employing a wide annularly shaped photodetector ring configuration and performing SpO_2 measurements from the forehead region." Ex. 1024, 3016.[3]

Mendelson-2003 explains that pulse oximetry uses sensors to monitor oxygen saturation (SpO_2), where the sensor typically includes light emitting diodes (LED) and a silicon photodetector (PD). *Id.* According to Mendelson-2003, when designing a pulse oximeter, it is important to offer "low power management without compromising signal quality." *Id.* at 3017. "However, high brightness LEDs commonly used in pulse oximeters require[] relatively high current pulses, typically in the range between 100–200mA. Thus, minimizing the drive currents supplied to the LEDs would contribute considerably toward the overall power saving in the design of a more efficient pulse oximeter." To achieve this goal, Mendelson-2003 discusses previous studies in which

> the driving currents supplied to the LEDs . . . could be lowered significantly without compromising the quality of the

---

[3] Petitioner cites to the native page numbers appearing at the top of Exhibit 1024, rather than the added page numbering at the bottom of the pages. We follow Petitioner's numbering scheme.

> [photoplethysmographic signal] by increasing the overall size of the PD . . . . Hence, by maximizing the light collected by the sensor, a very low power-consuming sensor could be developed, thereby extending the overall battery life of a pulse oximeter intended for telemedicine applications.

Id.

Mendelson-2003 discloses the prototype of such a sensor in Figure 1, which is reproduced below, and served as the basis for the studies evaluated in Mendelson-2003.

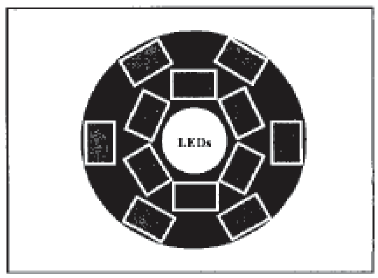


Figure 1 of Mendelson-2003 depicts a sensor configuration showing the relative positions of its PDs and LEDs. *Id.* As shown in Figure l, "six PDs were positioned in a close inner-ring configuration at a radial distance of 6.0mm from the LEDs. The second set of six PDs spaced equally along an outer-ring, separated from the LEDs by a radius of 10.0mm." *Id.* Mendelson-2003 also explains that "[e]ach cluster of six PDs were wired in parallel and connected through a central hub to the common summing input of a current-to-voltage converter." *Id.*

Mendelson-2003 reports the results of the studies as follows:

> Despite the noticeable differences between the PPG signals measured from the wrist and forehead, the data plotted in Fig. 3 also revealed that considerable stronger PPGs could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity. The additional increase, however, depends on the area and relative position of the PD with respect to the LEDs. For example,

> utilizing the outer-ring configuration, the overall increase in the average amplitudes of the R and IR PPGs measured from the forehead region was 23% and 40%, respectively. Similarly, the same increase in PD area produced an increase in the PPG signals measured from the wrist, but with a proportional higher increase of 42% and 73%.

Id. at 3019.

3. Overview of Ohsaki (Ex. 1014)

Ohsaki is a U.S. patent application publication titled "Wristwatch-type Human Pulse Wave Sensor Attached on Back Side of User's Wrist," and discloses an optical sensor for detecting a pulse wave of a human body. Ex. 1014, code (54), ¶ 3. Figure 1 of Ohsaki is reproduced below.

FIG. 1

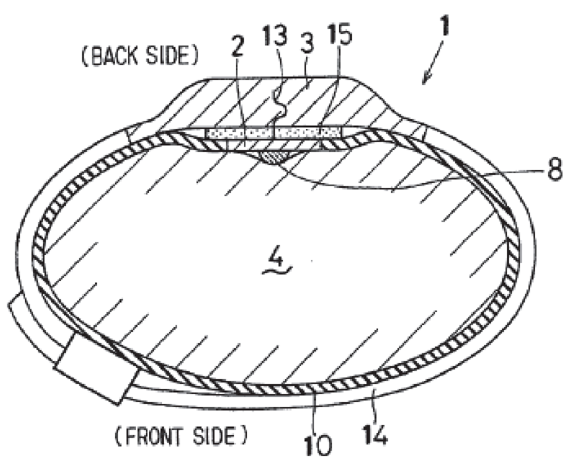


Figure 1 illustrates a cross-sectional view of pulse wave sensor 1 attached on the back side of user's wrist 4. *Id.* ¶¶ 12, 16. Pulse wave sensor 1 includes detecting element 2 and sensor body 3. *Id.* ¶ 16.

Figure 2 of Ohsaki, reproduced below, illustrates further detail of detecting element 2.

FIG. 2

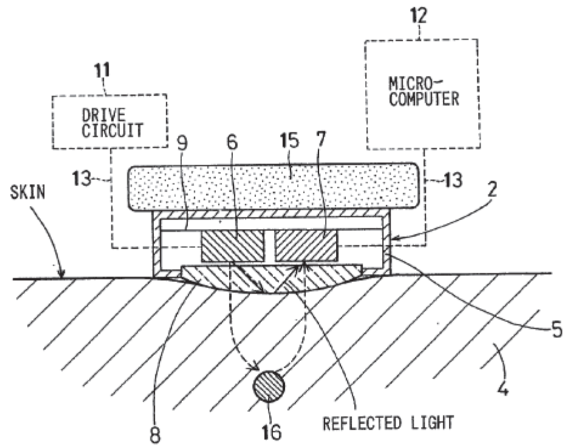


Figure 2 illustrates a mechanism for detecting a pulse wave. *Id.* ¶ 13. Detecting element 2 includes package 5, light emitting element 6, light receiving element 7, and translucent board 8. *Id.* ¶ 17. Light emitting element 6 and light receiving element 7 are arranged on circuit board 9 inside package 5. *Id.* ¶¶ 17, 19.

"[T]ranslucent board 8 is a glass board which is transparent to light, and attached to the opening of the package 5. A convex surface is formed on the top of the translucent board 8." *Id.* ¶ 17. "[T]he convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin," preventing detecting element 2 from slipping off the detecting position of the user's wrist. *Id.* ¶ 25. By preventing the detecting element from moving, the convex surface suppresses "variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin." *Id.* Additionally, the convex surface prevents penetration by "noise such as disturbance light from the outside." *Id.*

Sensor body 3 is connected to detecting element 2 by signal line 13. *Id.* ¶ 20. Signal line 13 connects detecting element 2 to drive circuit 11, microcomputer 12, and a monitor display (not shown). *Id.* Drive circuit 11 drives light emitting element 6 to emit light toward wrist 4. *Id.* Detecting element 2 receives reflected light which is used by microcomputer 12 to calculate pulse rate. *Id.* "The monitor display shows the calculated pulse rate." *Id.*

4. Goldsmith (Ex. 1027)

Goldsmith is a U.S. patent application publication titled "Watch Controller for a Medical Device," and discloses a watch controller device that communicates with an infusion device to "provid[e] convenient monitoring and control of the infusion pump device." Ex. 1027, code (57).

Goldsmith's Figure 9A is reproduced below.

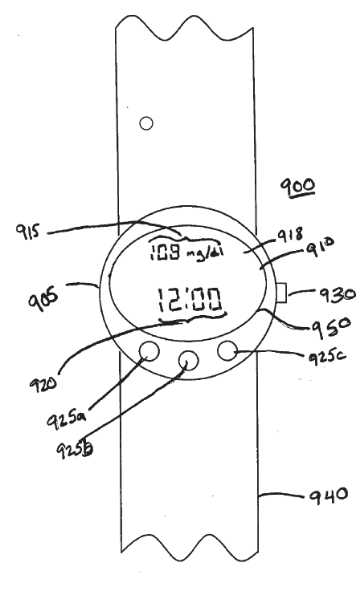


FIG.9A

Figure 9A is a front view of a combined watch and controller device. *Id.* ¶ 30. As shown in Figure 9A, watch controller 900 includes housing 905,

transparent member 950, display 910, rear-side cover 960, input devices 925a–c, 930, and wrist band 940. *Id.* ¶¶ 85–86, Fig. 9B.

Goldsmith discloses that the watch controller may interact with one or more devices, such as infusion pumps or analyte monitors. *Id.* ¶ 85; *see also id.* ¶ 88 ("The analyte sensing device 1060 may be adapted to receive data from a sensor, such as a transcutaneous sensor."). Display 910 "may display at least a portion of whatever information and/or graph is being displayed on the infusion device display or on the analyte monitor display," such as, e.g., levels of glucose. *Id.* ¶ 86. Additionally, the watch controller may communicate with a remote station, e.g., a computer, to allow data downloading. *Id.* ¶ 89 (including wireless).

5. Independent Claim 1

Petitioner presents undisputed contentions that claim 1 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith. Pet. 6–85.

i. "A user-worn physiological measurement device that defines a plurality of optical paths, the physiological measurement device comprising"

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses a pulse sensor that defines a plurality of optical paths, and that Goldsmith teaches an analyte sensor that is part of a user-worn controller device that includes, e.g., a display.[4] Pet. 36–37; *see, e.g.*, Ex. 1006 ¶¶ 2 (disclosing "a pulse wave sensor for detecting the pulse

[4] Whether the preamble is limiting need not be resolved at this stage of the proceeding because Petitioner shows sufficiently for purposes of institution that the recitation in the preamble is satisfied by the prior art.

wave of a subject"), 27 (discussing optical path), Fig. 1(b) (depicting two optical paths from emitter 21 to detectors 22 in Aizawa's sensor); Ex. 1027 ¶¶ 85 ("a watch"), 88 ("analyte sensing device 1060"), Fig. 9A.

Petitioner further contends that a person of ordinary skill in the art would have found it obvious to incorporate Aizawa's sensor "into Goldsmith's integrated wrist-worn watch controller device that includes, among other features, a touch screen, network interface, and storage device" in order to receive and display data sensed by Aizawa's sensor. Pet. 30–31; *see, e.g.*, Ex. 1003 ¶¶ 88–89. Petitioner contends this is consistent with Aizawa's disclosure of a transmitter that transmits pulse rate data to a display. Pet. 29; *see, e.g.*, Ex. 1006 ¶¶ 23 (disclosing "a transmitter for transmitting the above pulse rate data to an unshown display"), 35 ("[P]ulse rate data is transmitted to the display or the device for computing the amount of motion load."); Ex. 1003 ¶ 86. According to Petitioner, this would have "enable[d] a user to view and interact with heart rate data during exercise via the Goldsmith's touch-screen display, and to enable heart rate data to be monitored by the user and/or others through any of the devices with which Goldsmith's device can communicate." Pet. 31; *see, e.g.*, Ex. 1003 ¶ 90. Petitioner asserts this would have been use of a known technique to improve similar devices in the same way. Pet. 32; *see, e.g.*, Ex. 1003 ¶ 91; *see also* Pet. 32–35 (also discussing physical incorporation); *see, e.g.*, Ex. 1003 ¶¶ 92–94 (same).

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 86–96.

ii. "[a] one or more emitters configured to emit light into tissue of a user"

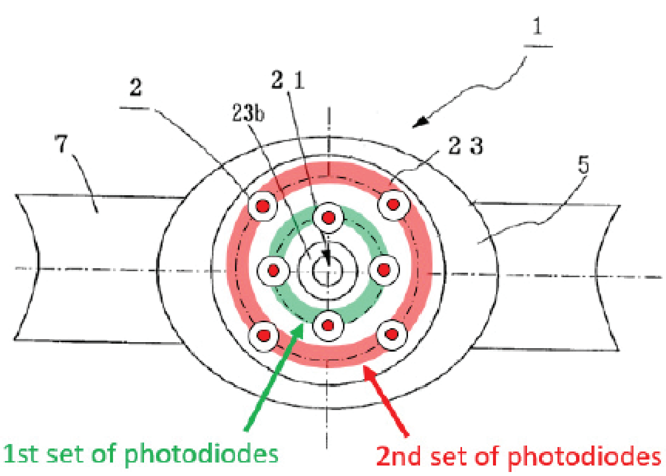
On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses that its sensor includes LED 21 that emits light into a user's tissue. Pet. 37–38; *see, e.g.*, Ex. 1006 ¶ 23 ("LED 21 . . . for emitting light having a wavelength of a near infrared range"), 27 (explaining that light is emitted toward the wrist), Fig. 1(b) (depicting emitter 21 facing user tissue 10). Fig. 2 (depicting sensor worn on user's wrist).

iii. "[b] a first set of photodiodes positioned on a first surface and surrounded by a wall that is operably connected to the first surface, wherein: [c] the first set of photodiodes comprises at least four photodiodes"
and
"[e] a second set of photodiodes positioned on the first surface and surrounded by the wall, wherein: [f] the second set of photodiodes comprises at least four photodiodes"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 16–22, 38–41, 46–48. Specifically, Petitioner contends that Aizawa discloses a first set of four photodiodes that are circularly arranged around a central emitter. *Id.* at 16–17; *see, e.g.*, Ex. 1006 ¶ 23 ("four phototransistors 22"), Figs. 1(a)–1(b) (depicting detectors 22 surrounding LED 21). Petitioner contends that Aizawa teaches that eight or more detectors may be used to improve detection efficiency, but does not expressly teach a "second set of photodiodes," as claimed. Pet. 17–18; *see, e.g.*, Ex. 1006 ¶ 32 ("the number of the photodetectors 22 may be increased"), Fig. 4(a).

According to Petitioner, Mendelson-2003 teaches two rings of photodiodes, which improve light collection efficiency, permit use of lower brightness LEDs, and reduce power consumption. Pet. 19; *see, e.g.*, Ex. 1024, 3017 ("[S]ix PDs [(photodetectors)] were positioned in a close inner-ring configuration . . . The second set of six PDs [were] spaced equally along an outer-ring."), 3019 (explaining that "considerabl[y] stronger [photoplethysmographic signals] could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity").

In view of these teachings, Petitioner contends, with reference to the modified and annotated figure reproduced below, that a person of ordinary skill in the art would have found it obvious to modify Aizawa to include an additional ring of detectors (a "second set") because this would have been "the use of known solutions to improve similar systems and methods in the same way," and would have led to benefits "in terms of achieving 'power savings in the design of a more efficient' pulse sensing device," wherein "the power consumption of a wrist-based pulse sensing device as in Aizawa can be reduced through use of a less bright and, hence, lower power-consuming LED." Pet. 20–22; Ex. 1003 ¶¶ 70, 73–74, 76.



Petitioner's modified and annotated figure depicts Aizawa's sensor with Aizawa's first set of photodiodes (depicted as connected by a green ring) and modified to include a second set of photodiodes as taught by Mendelson-2003 (depicted as connected by a red ring). Pet. 21, 39, 46.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 68–76, 98–103, 110–112.

On this record, the cited evidence also supports Petitioner's contention that Aizawa discloses a wall that surrounds the photodiodes, including the second set as suggested by the combined teachings of Aizawa and Mendelson-2003, and which is operably connected to the surface of the sensor on which the photodiodes are positioned. Pet. 39–40; *see, e.g.*, Ex. 1006 ¶ 23 ("holder 23 for storing" LED 21 and detectors 22), Fig. 1(b) (depicting periphery of holder 23 surrounding the sensor components, including detectors 22, which are positioned on a surface); Ex. 1003 ¶¶ 100–102, 111.

iv. "[d] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream"
and
"[g] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream"

On this record, the cited evidence supports Petitioner's undisputed contention that Mendelson-2003 discloses that each set of photodiodes are connected in parallel to provide signal streams. Pet. 42–43, 48; Ex. 1024, 3017 ("Each cluster of six PDs were wired in parallel and connected through a central hub to the common summing input of a current-to-voltage

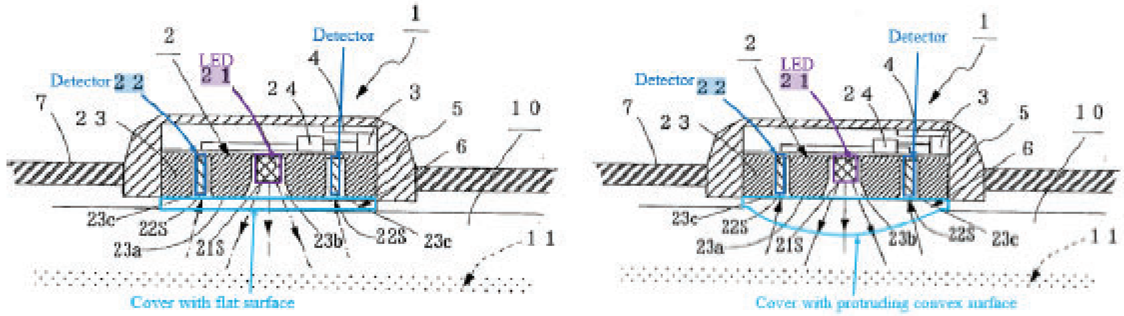
converter."); *see also* Pet. 41–46 (additional contentions); Ex. 1003 ¶¶ 106, 113.

v. "[h] a cover located above the wall and comprising a single protruding convex surface configured to be located between tissue of the user and the first and second sets of photodiodes when the physiological measurement device is worn by the user"

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 22–28, 49. Specifically, Petitioner contends that Aizawa "teaches a light permeable cover in the form of an acrylic transparent plate 6 . . . that is mounted at the detection face 23a" of the sensor, i.e., between the tissue of a user and the photodetectors. *Id.* at 8–9; Ex. 1006 ¶ 34 ("[A]crylic transparent plate 6 is provided on the detection face 23a of the holder 23 to improve adhesion to the wrist 10."), Fig. 1(b) (depicting flat, transparent plate 6 between sensor 2 and wrist 10). Petitioner also contends that Ohsaki teaches a wrist-worn sensor that includes a "translucent board" having a convex surface that contacts the user's skin to prevent slippage of the sensor. Pet. 11–12, 23; *see, e.g.*, Ex. 1014 ¶¶ 16 ("worn on the back side of the user's wrist"), 17 ("convex surface"), 25 ("intimate contact" prevents slippage), Figs. 1–2 (depicting convex translucent board 8 between tissue and detector).

Petitioner further contends, with reference to the modified and annotated figures reproduced below, that a person of ordinary skill in the art "would have found it obvious to modify [Aizawa's] sensor's flat cover (left) to include a lens/protrusion (right), similar to Ohsaki's translucent board 8, so as to improve adhesion between the user's wrist and the sensor's surface,

improve detection efficiency, and protect the elements within the sensor housing." Pet. 25–26; *see, e.g.*, Ex. 1003 ¶¶ 77, 80.



Petitioner's modified and annotated figures depict Aizawa's sensor as shown in Figure 1(b), modified to include a convex cover. *Id.* at 26; *see, e.g.*, Ex. 1014 ¶¶ 18 (explaining that outside disturbance light is prevented from penetrating the translucent board because "the surface of the translucent board 8 is in intimate contact with the surface of the user's skin"), 25 ("[T]he convex surface . . . is in intimate contact with the surface of the user's skin. Thereby it is prevented that the detecting element 2 slips off the detecting position of the user's wrist . . . . [Due to the] convex surface . . . the variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin is suppressed [and] [i]t is also prevented that noise such as disturbance light from the outside penetrates the translucent board 8. Therefore the pulse wave can be detected without being affected."); Ex. 1003 ¶¶ 77, 80; *see also* Pet. 26–29 (discussing further motivation and reasoning). Petitioner contends that, in the combination, the cover is "above" the wall provided by holder 23. Pet. 49; Ex. 1003 ¶ 114.

Petitioner also contends that combining these teachings "would have amounted to nothing more than the use of a known technique to improve similar devices in the same way." Pet. 26; *see, e.g.*, Ex. 1003 ¶ 81.

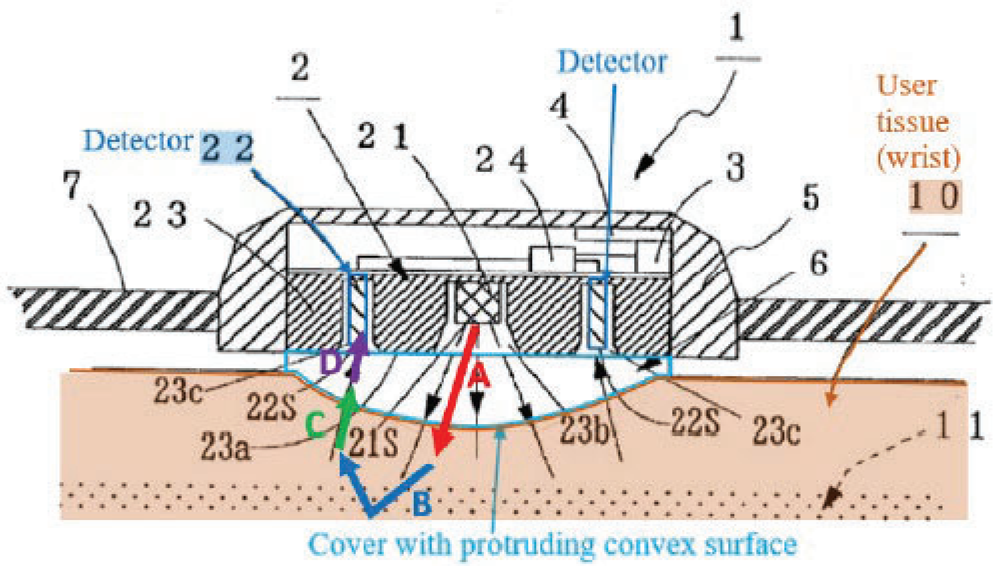
Petitioner contends that "the elements of the combined system would each perform similar functions they had been known to perform prior to the combination—Aizawa-Mendelson-2003's transparent plate 6 would remain in the same position, performing the same function, but with a convex surface as taught by Ohsaki." Pet. 26.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 77–85, 114.

> vi. *"[i] wherein the physiological measurement device provides a plurality of optical paths, wherein each of the optical paths: [j] exits an emitter of the one or more emitters, [k] passes through tissue of the user, [l] passes through the single protruding convex surface, and [m] arrives at a corresponding photodiode of the at least one of the first or second sets of photodiodes, the corresponding photodiode configured to receive light emitted by the emitter after traversal by the light of a corresponding optical path of the plurality of optical paths and after attenuation of the light by tissue of the user."*

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses a plurality of optical paths that exit emitter 21, pass through tissue 10, pass through the cover's convex surface (as modified in light of Ohsaki's teachings), and arrive at a photodiode of the first or second set of photodiodes (as modified in light of Mendelson-2003's teachings), wherein the photodiode receives the light that travels through the optical paths and is attenuated by the tissue, as shown in Petitioner's modified figure below. Pet. 51; *see, e.g.*, Ex. 1006 ¶ 27 ("Near infrared radiation output toward the wrist 10 from the light emitting diode 21

is reflected by a red corpuscle running through the artery 11 of the wrist 10 and this reflected light is detected by the plurality of photodetectors 22 so as to detect a pulse wave (see FIG. 1(b).”), Fig. 1(b) (depicting two optical paths from emitter 21 to detectors 22 in Aizawa’s sensor).



The annotated figure depicts “different sections of one of the optical paths,” in which “the optical path (A) exits an emitter, (B) passes through the tissue of the user, (C) passes through the single protruding convex surface, and (D) arrives at a corresponding photodiode.” Pet. 51; *see, e.g.*, Ex. 1003 ¶¶ 115–117.

vii.Summary

For the foregoing reasons, we are persuaded that Petitioner’s cited evidence and reasoning demonstrates a reasonable likelihood that Petitioner would prevail in its contentions regarding claim 1.

6. Claims 2–17

Petitioner presents undisputed contentions that independent claim 16, and dependent claims 2–15 and 17, which depend directly or indirectly from

independent claim 1 or 16, are unpatentable over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith, and provides arguments explaining how the references teach the limitations of these claims. Pet. 51–85; Ex. 1003 ¶¶ 118–186. Patent Owner does not offer, at this stage, any arguments addressing Petitioner's substantive showing. PO Waiver. We have reviewed these arguments and the cited evidence, and we determine Petitioner has demonstrated a reasonable likelihood of prevailing as to these contentions.

Moreover, as discussed in detail above, Petitioner has demonstrated a reasonable likelihood of prevailing on the challenge to claim 1. Therefore, pursuant to USPTO policy implementing the decision in *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348 (2018) ("*SAS*"), we institute as to all claims challenged in the petition and on all grounds in the petition. *See* PTAB Consolidated Trial Practice Guide (Nov. 2019) ("Consolidated Guide"),[5] 5–6, 64.

E. Additional Ground

Petitioner provides arguments and evidence, including the Kenny Declaration, in support of Petitioner's additional ground challenging dependent claims of the '195 patent. Pet. 86–89;[6] Ex. 1003 ¶¶ 187–191.

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[5] Available at https://www.uspto.gov/TrialPracticeGuideConsolidated.

[6] Petitioner asserts this ground applies to all of claims 1–17 (Pet. 86), however, Petitioner presents contentions regarding only dependent claim 10 (*id.* at 88–89 (presenting contentions "[t]o the extent that Patent Owner argues that Aizawa-Mendelson-2003-Ohsaki-Goldsmith does not render [10g] obvious"). As such, we understand this challenge to apply to claim 10 and the claims that depend from it, i.e., claims 11–15. *See* Ex. 1003 ¶ 187 ("just for element [10g]").

Patent Owner does not offer, at this stage, any arguments addressing Petitioner's substantive showing. PO Waiver. We have reviewed these arguments and the cited evidence, and we determine Petitioner has demonstrated a reasonable likelihood of prevailing as to these contentions. We institute review of all of these challenges. *See SAS*, 138 S. Ct. 1348; Consolidated Practice Guide, 5–6, 64.

III. CONCLUSION

The Supreme Court held that a final written decision under 35 U.S.C. § 318(a) must decide the patentability of all claims challenged in the petition. *See SAS*, 138 S. Ct. 1348. After considering the evidence and arguments presented in the Petition, we determine that Petitioner has demonstrated a reasonable likelihood of success in proving that at least claims 1 and 16 of the '195 patent are unpatentable. Accordingly, we institute an *inter partes* review of all claims and all grounds set forth in the Petition.[7]

At this stage of the proceeding, we have not made a final determination as to the patentability of any challenged claim or as to the construction of any claim term.

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[7] The Petition addresses the Board's discretion under 35 U.S.C. §§ 314(a) and 325(d). *See* Pet. 89–94. Patent Owner does not argue that we should exercise discretion to deny institution of *inter partes* review. *See* PO Waiver. Accordingly, we do not consider exercising discretion to deny institution of *inter partes* review under 35 U.S.C. §§ 314(a) and 325(d) any further.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 1–17 of the ’195 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the ’195 patent shall commence on the entry date of this Order, and notice is hereby given of the institution of a trial.

Case: 22-1972 Document: 33 Page: 194 Filed: 08/01/2023

FOR PETITIONER:

W. Karl Renner
Roberto Devoto
Hyun Jin In
FISH & RICHARDSON P.C.
axf-ptab@fr.com
devoto@fr.com
in@fr.com

FOR PATENT OWNER:

Joseph R. Re
Stephen W. Larson
Jarom D. Kesler
Jacob L. Peterson
KNOBBE, MARTENS, OLSON, & BEAR, LLP
2jrr@knobbe.com
2swl@knobbe.com
2jzk@knobbe.com
2jup@knobbe.com

Trials@uspto.gov
571-272-7822

Paper 7
Entered: May 12, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

MASIMO CORPORATION,
Patent Owner.

IPR2020-01737
Patent 10,709,366 B1

Before JOSIAH C. COCKS, ROBERT L. KINDER, and AMANDA F. WIEKER, *Administrative Patent Judges*.

KINDER, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background

Apple Inc. ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1–27 ("challenged claims") of U.S. Patent No. 10,709,366 B1 (Ex. 1001, "the '366 patent"). Paper 2 ("Pet."). Masimo Corporation ("Patent Owner") waived filing a preliminary response. Paper 6 ("PO Waiver").

We have authority to determine whether to institute an *inter partes* review, under 35 U.S.C. § 314 and 37 C.F.R. § 42.4. An *inter partes* review may not be instituted unless it is determined that "the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314 (2018); *see also* 37 C.F.R. § 42.4(a) (2020) ("The Board institutes the trial on behalf of the Director.").

For the reasons provided below and based on the record before us, we determine that Petitioner has demonstrated a reasonable likelihood that Petitioner would prevail in showing the unpatentability of at least one of the challenged claims. Accordingly, we institute an *inter partes* review on all grounds set forth in the Petition.

B. Related Matters

The parties identify the following matters related to the '366 patent:

Masimo Corporation v. Apple Inc., Civil Action No. 8:20-cv-00048 (C.D. Cal.);

Apple Inc. v. Masimo Corporation, IPR2020-01520 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,258,265 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01521 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,292,628 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01523 (PTAB Sept. 9, 2020) (challenging claims of U.S. Patent No. 8,457,703 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01524 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,433,776 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01526 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 6,771,994 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01536 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01537 (PTAB Aug. 31, 2020) (challenging claims of U.S. Patent No. 10,588,553 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01538 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01539 (PTAB Sept. 2, 2020) (challenging claims of U.S. Patent No. 10,588,554 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01713 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,624,564 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01714 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01715 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,631,765 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01716 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,194 B1);

Apple Inc. v. Masimo Corporation, IPR2020-01722 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2);

Apple Inc. v. Masimo Corporation, IPR2020-01723 (PTAB Oct. 2, 2020) (challenging claims of U.S. Patent No. 10,470,695 B2); and

Apple Inc. v. Masimo Corporation, IPR2020-01733 (PTAB Sept. 30, 2020) (challenging claims of U.S. Patent No. 10,702,195 B1).

Pet. 94–95; Paper 3, 3–4.

Patent Owner further identifies the following pending patent applications, among other issued and abandoned applications, that claim priority to, or share a priority claim with, the '366 patent:

U.S. Patent Application No. 16/834,538;

U.S. Patent Application No. 16/449,143; and

U.S. Patent Application No. 16/805,605.

Paper 3, 1–2.

C. The '366 Patent

The '366 patent is titled "Multi-Stream Data Collection System for Noninvasive Measurement of Blood Constituents," and issued on July 14, 2020, from U.S. Patent Application No. 16/829,510, filed March 25, 2020. Ex. 1001, codes (21), (22), (45), (54). The '366 patent claims priority through a series of continuation and continuation-in-part applications to Provisional Application Nos. 61/086,060, 61/086,108, 61/086,063, 61/086,057, each filed August 4, 2008, as well as 61/091,732 filed

August 25, 2008, and 61/078,228 and 61/078,207, both filed July 3, 2008.[1] *Id.* at codes (60), (63).

The '366 patent discloses a two-part data collection system including a noninvasive sensor that communicates with a patient monitor. *Id.* at 2:38–40. The sensor includes a sensor housing, an optical source, and several photodetectors, and is used to measure a blood constituent or analyte, e.g., oxygen or glucose. *Id.* at 2:29–37, 2:62–3:12. The patient monitor includes a display and a network interface for communicating with a handheld computing device. *Id.* at 2:42–48.

[1] The Office has made the prior determination that the application leading to the '366 patent should be examined under the pre-AIA first to invent provisions. *See* Ex. 1002, 199 (Apr. 10, 2020 Decision Granting Request for Prioritized Examination, marking "No" for "AIA (FITF) Status"). We determine that based on this prior determination, and the lack of any contrary evidence before us, the Petition was not required to be filed more than nine months after the date of the grant of the patent. *See* 37 C.F.R. § 42.102(a)(1). Instead, based on the record before us, 37 C.F.R. § 42.102(a)(2) should apply, which allows a petition to be filed after "the date of the grant of the patent."

Figure 1 of the ’366 patent is reproduced below.

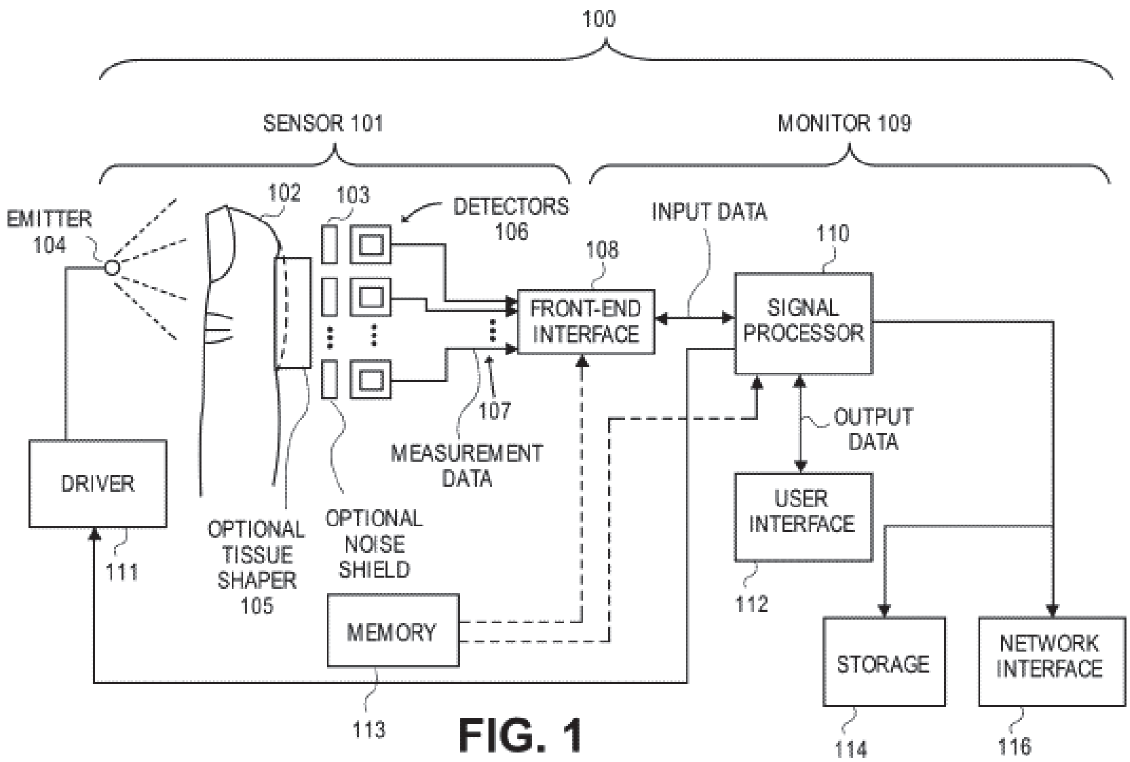

FIG. 1

Figure 1 illustrates a block diagram of data collection system 100 including sensor 101 and monitor 109. *Id.* at 11:51–61. Sensor 101 includes optical emitter 104 and detectors 106. *Id.* Emitters 104 emit light that is attenuated or reflected by the patient’s tissue at measurement site 102. *Id.* at 11:61–63; 14:4–7. Detectors 106 capture and measure the light attenuated or reflected from the tissue. *Id.* at 14:3–10. In response to the measured light, detectors 106 output detector signals 107 to monitor 109 through front-end interface 108. *Id.* at 14:7–10, 28–33. Sensor 101 also may include tissue shaper 105, which may be in the form of a convex surface that: (1) reduces the thickness of the patient’s measurement site; and (2) provides more surface area from which light can be detected. *Id.* at 10:61–11:13.

Monitor 109 includes signal processor 110 and user interface 112. *Id.* at 15:16–18. “[S]ignal processor 110 includes processing logic that

determines measurements for desired analytes, . . . based on the signals received from the detectors 106." *Id.* at 15:20–24. User interface 112 presents the measurements to a user on a display, e.g., a touch-screen display. *Id.* at 15:46–50. The monitor may be connected to storage device 114 and network interface 116. *Id.* at 15:60–67.

The '366 patent describes various examples of sensor devices. Figures 14D and 14F, reproduced below, illustrate sensor devices.

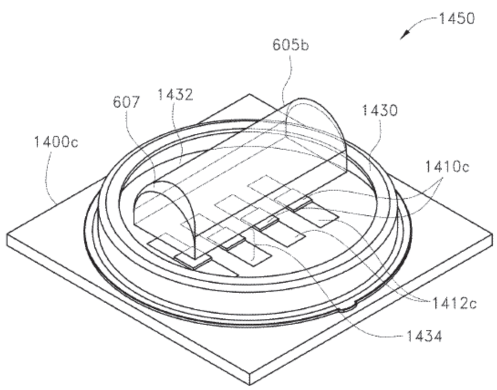

FIG. 14D

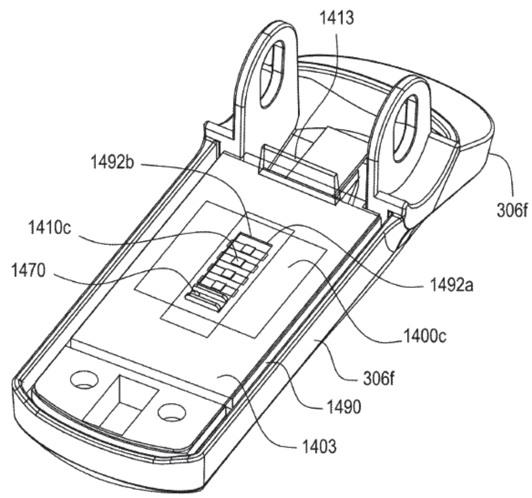

FIG. 14F

Figure 14D (left) illustrates portions of a detector submount and Figure 14F (right) illustrates portions of a detector shell. *Id.* at 6:44–47. As shown in Figure 14D, multiple detectors 1410c are located within housing 1430 and under transparent cover 1432, on which protrusion 605b (or partially cylindrical protrusion 605) is disposed. *Id.* at 35:39–43, 36:30–41. Figure 14F illustrates a detector shell 306f including detectors 1410c on substrate 1400c. *Id.* at 37:9–17. Substrate 1400c is enclosed by shielding enclosure 1490 and noise shield 1403, which include window 1492a and window 1492b, respectively, placed above detectors 1410c. *Id.*

Alternatively, cylindrical housing 1430 may be disposed under noise shield 1403 and may enclose detectors 1410c. *Id.* at 37:47–49.

Figures 4A and 4B, reproduced below, illustrate an alternative example of a tissue contact area of a sensor device.

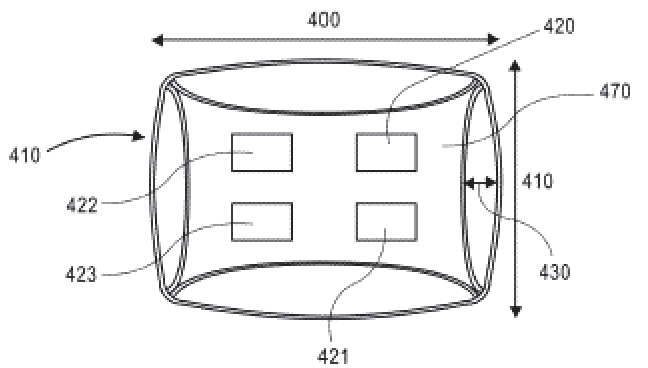

FIG. 4A

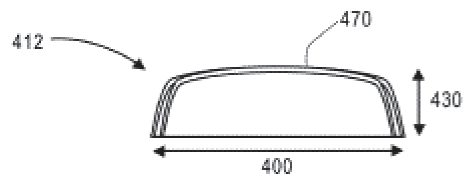

FIG. 4B

Figures 4A and 4B illustrate arrangements of protrusion 405 including measurement contact area 470. *Id.* at 23:18–24. "[M]easurement site contact area 470 can include a surface that molds body tissue of a measurement site." *Id.* "For example, . . . measurement site contact area 470 can be generally curved and/or convex with respect to the measurement site." *Id.* at 23:41–43. The measurement site contact area may include windows 420–423 that "mimic or approximately mimic a configuration of, or even house, a plurality of detectors." *Id.* at 23:49–63.

D. Illustrative Claim

Of the challenged claims, claims 1, 14, and 27 are independent. Claim 1 is illustrative and is reproduced below.

> 1. A noninvasive physiological parameter measurement device adapted to be worn by a wearer, the noninvasive physiological parameter measurement device comprising:
>
> [a] one or more light emitters;

[b] a substrate having a surface;

[c] a first set of photodiodes arranged on the surface and spaced apart from each other, wherein:

[d] the first set of photodiodes comprises at least four photodiodes, and

[e] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue;

[f] a second set of photodiodes arranged on the surface and spaced apart from each other, wherein:

[g] the second set of photodiodes comprises at least four photodiodes,

[h] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue, and

[i] at least one of the first signal stream or the second signal stream includes information usable to determine a physiological parameter of a wearer of the noninvasive physiological parameter measurement device;

[j] a wall extending from the surface and configured to surround at least the first and second sets of photodiodes; and

[k] a cover arranged to cover at least a portion of the surface of the substrate, wherein the cover comprises a protrusion that extends over all of the photodiodes of the first and second sets of photodiodes arranged on the surface, and wherein the cover is further configured to cover the wall.

Ex. 1001, 44:57–45:27 (bracketed identifiers [a]–[k] added). Independent claim 14 includes limitations substantially similar to limitations [a], [c]–[h], [j], and [k] and includes additional limitations drawn to "one or more processors configured to: receive information . . . ; [and], process the

information to determine physiological parameter measurement information." *Id.* at 46:33–56. Independent Claim 27 contains numerous limitations, which are integrated from claim 1 (limitations [a]–[k]) as well as limitations from numerous dependent claims. *Id.* at 48:1–49:10; Pet. 81–84.

E. Applied References

Petitioner relies upon the following references:

Sherman et al., U.S. Patent No. 4,941,236, filed July 9, 1989, issued July 17, 1990 (Ex. 1047, "Sherman");

Ohsaki et al., U.S. Patent Application Publication No. 2001/0056243 A1, filed May 11, 2001, published December 27, 2001 (Ex. 1014, "Ohsaki");

Aizawa, U.S. Patent Application Publication No. 2002/0188210 A1, filed May 23, 2002, published December 12, 2002 (Ex. 1006, "Aizawa");

Goldsmith et al., U.S. Patent Application Publication No. 2007/0093786 A1, filed July 31, 2006, published April 26, 2007 (Ex. 1027, "Goldsmith); and

Y. Mendelson, et al., "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," Proceedings of the 25th IEEE EMBS Annual International Conference, 3016-3019 (2003) (Ex. 1024, "Mendelson-2003").

Pet. 1–2. Petitioner also submits, *inter alia*, the Declaration of Thomas W. Kenny, Ph.D. (Ex. 1003).

F. Asserted Grounds

Petitioner asserts that claims 1–27 are unpatentable based upon the following grounds (Pet. 1–2):

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1–12, 14–27	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith
13	103	Aizawa, Mendelson-2003, Ohsaki, Goldsmith, Sherman

II. DISCUSSION

A. Claim Construction

For petitions filed on or after November 13, 2018, a claim shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b) (2020). Petitioner submits that no claim term requires express construction. Pet. 3.

Based on our analysis of the issues in dispute at this stage of the proceeding, we agree that no claim terms require express construction at this time. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Matal*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

B. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103 if "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406

(2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of non-obviousness.[2] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). When evaluating a combination of teachings, we must also "determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue." *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). Whether a combination of prior art elements would have produced a predictable result weighs in the ultimate determination of obviousness. *Id.* at 416–417.

In an *inter partes* review, the petitioner must show with particularity why each challenged claim is unpatentable. *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016); 37 C.F.R. § 42.104(b). The burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

C. Level of Ordinary Skill in the Art

Petitioner identifies the appropriate level of skill in the art as that possessed by a person having "a Bachelor of Science degree in an academic discipline emphasizing the design of electrical, computer, or software technologies, in combination with training or at least one to two years of

[2] Patent Owner does not present objective evidence of non-obviousness at this stage.

related work experience with capture and processing of data or information." Pet. 3 (citing Ex. 1003 ¶¶ 21–22). "Alternatively, the person could have also had a Master of Science degree in a relevant academic discipline with less than a year of related work experience in the same discipline." *Id.*

For purposes of this Decision, we generally adopt Petitioner's assessment as set forth above, which appears consistent with the level of skill reflected in the Specification and prior art.

D. Obviousness over the Combined Teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith

Petitioner presents undisputed contentions that claims 1–12 and 14–27 of the '366 patent would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith. Pet. 8–84.

1. Overview of Aizawa (Ex. 1006)

Aizawa is a U.S. patent application publication titled "Pulse Wave Sensor and Pulse Rate Detector," and discloses a pulse wave sensor that detects light output from a light emitting diode and reflected from a patient's artery. Ex. 1006, codes (54), (57).

Figure 1(a) of Aizawa is reproduced below.

FIG. 1 (a)

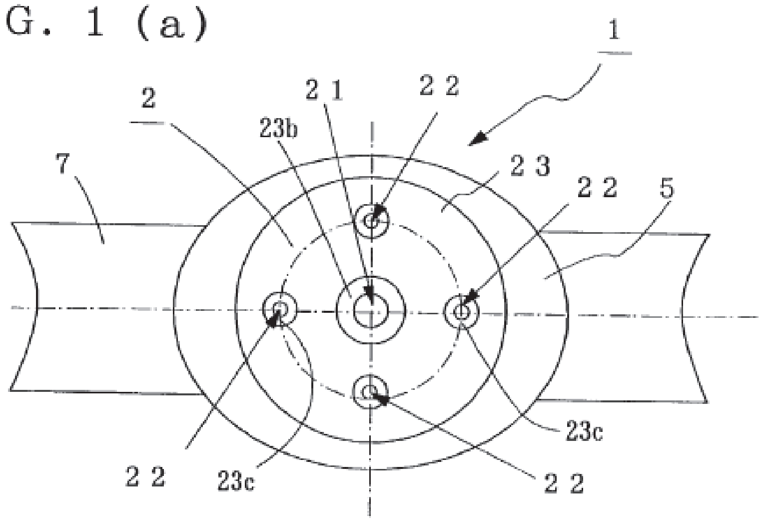

Figure 1(a) is a plan view of a pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(a), pulse wave sensor 2 includes light emitting diode ("LED") 21, four photodetectors 22 symmetrically disposed around LED 21, and holder 23 for storing LED 21 and photodetectors 22. *Id.* Aizawa discloses that, "to further improve detection efficiency, . . . the number of the photodetectors 22 may be increased." *Id.* ¶ 32, Fig. 4(a). "The same effect can be obtained when the number of photodetectors 22 is 1 and a plurality of light emitting diodes 21 are disposed around the photodetector 22." *Id.* ¶ 33.

Figure 1(b) of Aizawa is reproduced below.

FIG. 1 (b)

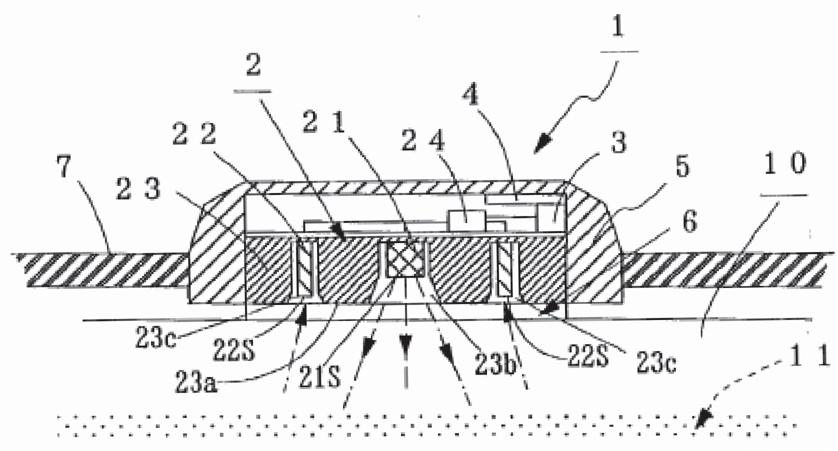

Figure 1(b) is a sectional view of the pulse wave sensor. *Id.* ¶ 23. As shown in Figure 1(b), pulse wave sensor 2 includes drive detection circuit 24 for detecting a pulse wave by amplifying the outputs of photodetectors 22. *Id.* ¶ 23. Arithmetic circuit 3 computes a pulse rate from the detected pulse wave and transmitter 4 transmits the pulse rate data to an "unshown display." *Id.* The pulse rate detector further includes outer casing 5 for storing pulse wave sensor 2, acrylic transparent plate 6 mounted to detection face 23a of holder 23, and attachment belt 7. *Id.*

Aizawa discloses that LED 21 and photodetectors 22 "are stored in cavities 23b and 23c formed in the detection face 23a" of the pulse wave sensor. *Id.* ¶ 24. Detection face 23a "is a contact side between the holder 23 and a wrist 10, respectively, at positions where the light emitting face 21s of the light emitting diode 21 and the light receiving faces 22s of the photodetectors 22 are set back from the above detection face 23a." *Id.* Aizawa discloses that "a subject carries the above pulse rate detector 1 on the inner side of his/her wrist 10 . . . in such a manner that the light emitting face 21s of the light emitting diode 21 faces down (on the wrist 10 side)."

Id. ¶ 26. Furthermore, "the above belt 7 is fastened such that the acrylic transparent plate 6 becomes close to the artery 11 of the wrist 10. Thereby, adhesion between the wrist 10 and the pulse rate detector 1 is improved." *Id.* ¶¶ 26, 34.

2. Overview of Mendelson-2003 (Ex. 1024)

Mendelson-2003 is a journal article titled "Measurement Site and Photodetector Size Considerations in Optimizing Power Consumption of a Wearable Reflectance Pulse Oximeter," which discusses a pulse oximeter sensor in which "battery longevity could be extended considerably by employing a wide annularly shaped photodetector ring configuration and performing SpO_2 measurements from the forehead region." Ex. 1024, 3016.[3]

Mendelson-2003 explains that pulse oximetry uses sensors to monitor oxygen saturation (SpO_2), where the sensor typically includes light emitting diodes (LED) and a silicon photodetector (PD). *Id.* According to Mendelson-2003, when designing a pulse oximeter, it is important to offer "low power management without compromising signal quality." *Id.* at 3017. "However, high brightness LEDs commonly used in pulse oximeters require[] relatively high current pulses, typically in the range between 100–200mA. Thus, minimizing the drive currents supplied to the LEDs would contribute considerably toward the overall power saving in the design of a more efficient pulse oximeter." To achieve this goal, Mendelson-2003 discusses previous studies in which

> the driving currents supplied to the LEDs . . . could be lowered significantly without compromising the quality of the

[3] We adopt Petitioner's citation format by referring to the original page numbering and not Petitioner's added page numbering at the bottom.

> [photoplethysmographic or PPG signals] by increasing the overall size of the PD . . . . Hence, by maximizing the light collected by the sensor, a very low power-consuming sensor could be developed, thereby extending the overall battery life of a pulse oximeter intended for telemedicine applications.

Id.

Mendelson-2003 discloses the prototype of such a sensor in Figure 1, which is reproduced below, and served as the basis for the studies evaluated in Mendelson-2003.

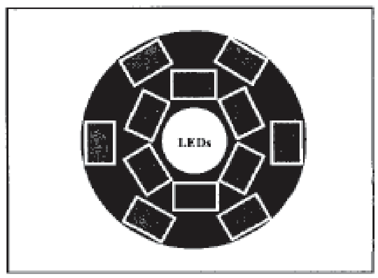

Figure 1 of Mendelson-2003 depicts a sensor configuration showing the relative positions of its PDs and LEDs. *Id.* As shown in Figure l, "six PDs were positioned in a close inner-ring configuration at a radial distance of 6.0mm from the LEDs. The second set of six PDs spaced equally along an outer-ring, separated from the LEDs by a radius of 10.0mm." *Id.* Mendelson-2003 also explains that "[e]ach cluster of six PDs were wired in parallel and connected through a central hub to the common summing input of a current-to-voltage converter." *Id.*

Mendelson-2003 reports the results of the studies as follows:

> Despite the noticeable differences between the PPG signals measured from the wrist and forehead, the data plotted in Fig. 3 also revealed that considerable stronger PPGs could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity. The additional increase, however, depends on the area and relative position of the PD with respect to the LEDs. For example,

> utilizing the outer-ring configuration, the overall increase in the average amplitudes of the R and IR PPGs measured from the forehead region was 23% and 40%, respectively. Similarly, the same increase in PD area produced an increase in the PPG signals measured from the wrist, but with a proportional higher increase of 42% and 73%.

Id. at 3019.

3. Overview of Ohsaki (Ex. 1014)

Ohsaki is a U.S. patent application publication titled "Wristwatch-type Human Pulse Wave Sensor Attached on Back Side of User's Wrist," and discloses an optical sensor for detecting a pulse wave of a human body. Ex. 1014, code (54), ¶ 3. Figure 1 of Ohsaki is reproduced below.

FIG. 1

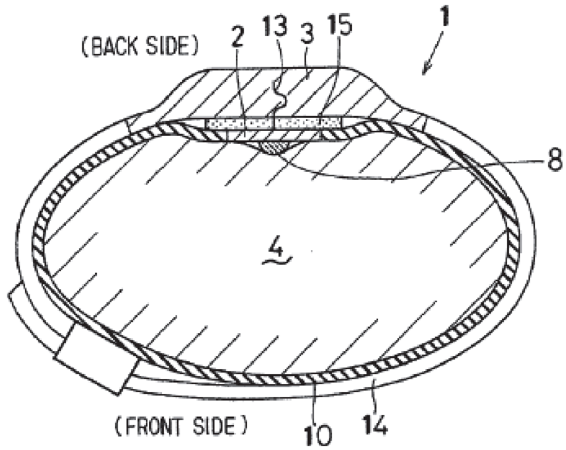

Figure 1 illustrates a cross-sectional view of pulse wave sensor 1 attached on the back side of user's wrist 4. *Id.* ¶¶ 12, 16. Pulse wave sensor 1 includes detecting element 2 and sensor body 3. *Id.* ¶ 16.

Figure 2 of Ohsaki, reproduced below, illustrates further detail of detecting element 2.

FIG. 2

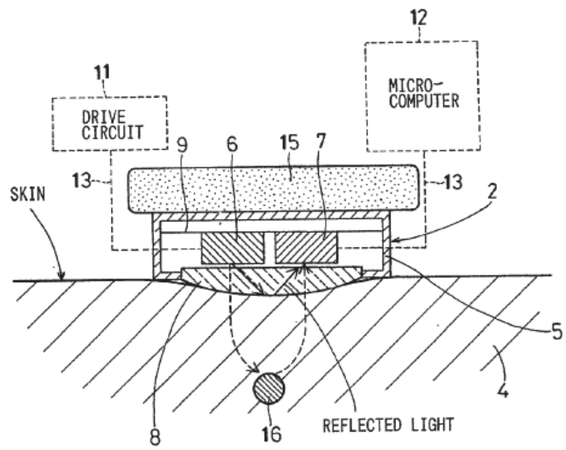

Figure 2 illustrates a mechanism for detecting a pulse wave. *Id.* ¶ 13. Detecting element 2 includes package 5, light emitting element 6, light receiving element 7, and translucent board 8. *Id.* ¶ 17. Light emitting element 6 and light receiving element 7 are arranged on circuit board 9 inside package 5. *Id.* ¶¶ 17, 19.

"[T]ranslucent board 8 is a glass board which is transparent to light, and attached to the opening of the package 5. A convex surface is formed on the top of the translucent board 8." *Id.* ¶ 17. "[T]he convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin," preventing detecting element 2 from slipping off the detecting position of the user's wrist 4. *Id.* ¶ 25. By preventing the detecting element from moving, the convex surface suppresses "variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin." *Id.* Additionally, the convex surface prevents penetration by "noise such as disturbance light from the outside." *Id.*

Sensor body 3 is connected to detecting element 2 by signal line 13. *Id.* ¶ 20. Signal line 13 connects detecting element 2 to drive circuit 11, microcomputer 12, and a monitor display (not shown). *Id.* Drive circuit 11 drives light emitting element 6 to emit light toward wrist 4. *Id.* Detecting element 2 receives reflected light which is used by microcomputer 12 to calculate pulse rate. *Id.* "The monitor display shows the calculated pulse rate." *Id.*

4. Goldsmith (Ex. 1027)

Goldsmith is a U.S. patent application publication titled "Watch Controller for a Medical Device," and discloses a watch controller device that communicates with an infusion device to "provid[e] convenient monitoring and control of the infusion pump device." Ex. 1027, code (57).

Goldsmith's Figure 9A is reproduced below.

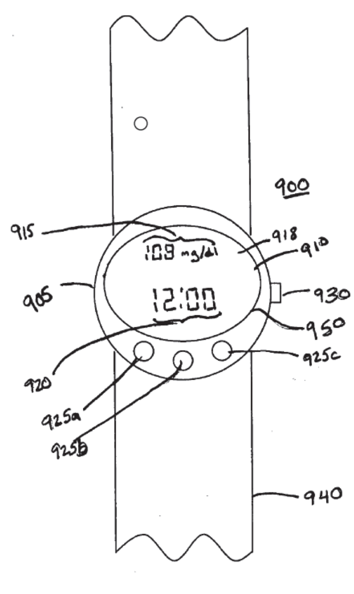

FIG. 9A

Figure 9A is a front view of a combined watch and controller device. *Id.* ¶ 30. As shown in Figure 9A, watch controller 900 includes housing 905,

transparent member 950, display 910, rear-side cover 960, input devices 925a–c, 930, and wrist band 940. *Id.* ¶¶ 85–86, Fig. 9B.

Goldsmith discloses that the watch controller may interact with one or more devices, such as infusion pumps or analyte monitors. *Id.* ¶ 85; *see also id.* ¶ 88 ("The analyte sensing device 1060 may be adapted to receive data from a sensor, such as a transcutaneous sensor."). Display 910 "may display at least a portion of whatever information and/or graph is being displayed on the infusion device display or on the analyte monitor display," such as, e.g., levels of glucose. *Id.* ¶ 86. Additionally, the watch controller may communicate with a remote station, e.g., a computer, to allow data downloading. *Id.* ¶ 89 (including wireless).

5. Independent Claim 1

Petitioner presents undisputed contentions that claim 1 would have been obvious over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith. Pet. 38–53. Petitioner's showing includes persuasive reasoning, on the current record, for combining the references in the manners proposed. Pet. 18–38.

i. "A noninvasive physiological parameter measurement device adapted to be worn by a wearer, the noninvasive physiological parameter measurement device comprising"

On this record, the cited evidence supports Petitioner's undisputed contention that "Aizawa discloses a pulse sensor that is designed to 'detect[] the pulse wave of a subject from light reflected from a red corpuscle in the artery of a wrist of the subject by irradiating the artery of the wrist,'" and that Goldsmith teaches an analyte sensor that is part of a user-worn

controller device that includes, e.g., a display.[4] Pet. 39 (quoting Ex. 1006 ¶ 2); *see also* Ex. 1006 ¶ 27 (discussing optical path), Fig. 2 (depicting physiological parameter measurement device worn by a user); Ex. 1027 ¶¶ 85 ("a watch"), 88 ("analyte sensing device 1060"), Fig. 9A; Ex. 1003 ¶ 94.

Petitioner further contends that a person of ordinary skill in the art would have found it obvious to incorporate Aizawa's sensor "into Goldsmith's integrated wrist-worn watch controller device that includes, among other features, a touch screen, network interface, and storage device" in order to receive and display data sensed by Aizawa's sensor. Pet. 31–34; *see, e.g.*, Ex. 1003 ¶¶ 88–89 ("would have enhanced the sensor's utility and improved the user's experience"). According to Petitioner, this would have "enable[d] a user to view and interact with heart rate data during exercise via the Goldsmith's touch-screen display, and to enable heart rate data to be monitored by the user and/or others through any of the devices with which Goldsmith's device can communicate." Pet. 34; *see, e.g.*, Ex. 1003 ¶ 89. Petitioner asserts this would have been use of a known technique to improve similar devices in the same way. Pet. 35; *see, e.g.*, Ex. 1003 ¶ 90; *see also* Pet. 35–38 (also discussing physical incorporation); *see, e.g.*, Ex. 1003 ¶¶ 90–93 (same).

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 88–94.

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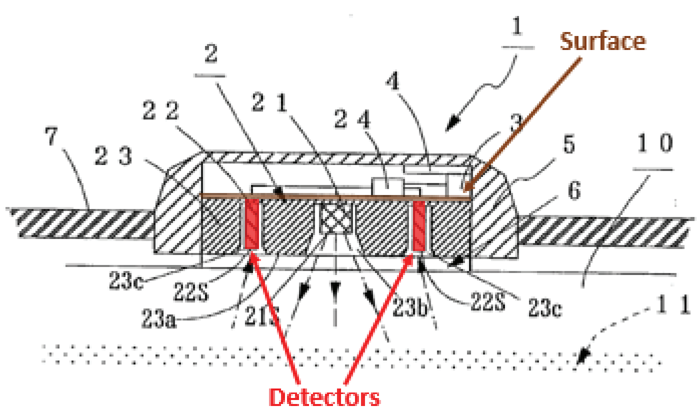
[4] Whether the preamble is limiting need not be resolved at this stage of the proceeding because Petitioner shows sufficiently for purposes of institution that the recitation in the preamble is satisfied by the prior art.

ii. "[a] one or more light emitters"
and
"[b] a substrate having a surface"

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses that its sensor includes LED 21 that emits light that is picked up by photodetectors. Pet. 40; *see, e.g.*, Ex. 1006 ¶ 23 ("LED 21 . . . for emitting light having a wavelength of a near infrared range"), 27 (explaining that light is emitted toward the wrist), Fig. 1(b) (depicting emitter 21 facing user tissue 10), Fig. 2 (depicting sensor worn on user's wrist).

Petitioner sufficiently shows on this record that a person of ordinary skill in the art would have understood that Aizawa's surface would include a substrate on which the detectors are arranged. Pet. 41. Petitioner relies on annotated Figure 1(b) of Aizawa, reproduced below.



Petitioner's annotated Figure 1(b) shows detectors highlighted in red and a substrate surface unnumbered but highlighted in brown. Pet. 41. Dr. Kenny likewise testifies that Aizawa teaches "a substrate having surface (shown in brown) on which the holder 23 is placed and on which the detectors/ photodiodes are arranged." Ex. 1003 ¶ 96.

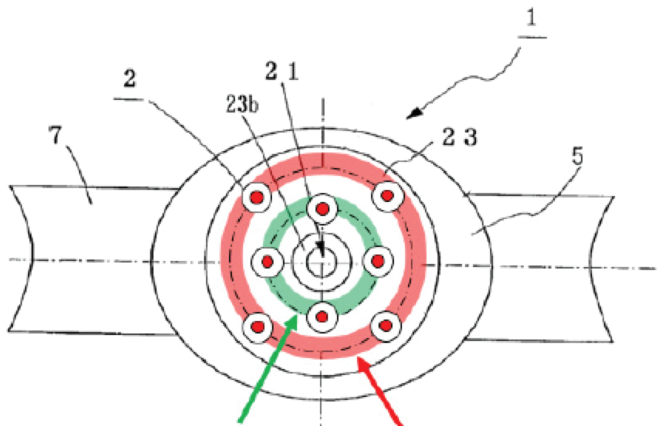
> *iii.[c] a first set of photodiodes arranged on the surface and spaced apart from each other, wherein: [d] the first set of photodiodes comprises at least four photodiodes, and"*
>
> *"[f] a second set of photodiodes arranged on the surface and spaced apart from each other, wherein: [g] the second set of photodiodes comprises at least four photodiodes,"*

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 18–25, 38–50. Specifically, Petitioner contends that Aizawa discloses a first set of four photodiodes that are circularly arranged around a central emitter. *Id.* at 18–19; *see, e.g.*, Ex. 1006 ¶ 23 ("four phototransistors 22"), Figs. 1(a)–1(b) (depicting detectors 22 surrounding LED 21). Petitioner contends that Aizawa teaches that eight or more detectors may be used to improve detection efficiency, but does not expressly teach a "second set of photodiodes," as claimed. Pet. 20–21; *see, e.g.*, Ex. 1006 ¶ 32 ("the number of the photodetectors 22 may be increased"), Fig. 4(a).

According to Petitioner, Mendelson-2003 teaches two rings of photodiodes, which improve light collection efficiency, permit use of lower brightness LEDs, and reduce power consumption. Pet. 21–22; *see, e.g.*, Ex. 1024, 3017 ("[S]ix PDs [(photodetectors)] were positioned in a close inner-ring configuration . . . The second set of six PDs [were] spaced equally along an outer-ring."), 3019 (explaining that "considerabl[y] stronger [photoplethysmographic signals] could be obtained by widening the active area of the PD which helps to collect a bigger proportion of backscattered light intensity").

In view of these teachings, Petitioner contends, with reference to the modified and annotated figure reproduced below, that a person of ordinary

skill in the art would have found it obvious to modify Aizawa to include an additional ring of detectors (a "second set") because this would have been "the use of known solutions to improve similar systems and methods in the same way," and would have led to benefits "in terms of achieving 'power savings in the design of a more efficient' pulse sensing device," wherein "the power consumption of a wrist-based pulse sensing device as in Aizawa can be reduced through use of a less bright and, hence, lower power-consuming LED." Pet. 23–25; Ex. 1003 ¶¶ 72, 74–75.



Petitioner's modified and annotated figure depicts Aizawa's sensor with Aizawa's first set of photodiodes (depicted as connected by a green ring) and modified to include a second set of photodiodes as taught by Mendelson-2003 (depicted as connected by a red ring). Pet. 23–24, 42, 49.

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 72, 74–75, 97–100, 107–109.

> *iv. "[e] the photodiodes of the first set of photodiodes are connected to one another in parallel to provide a first signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue;" and*

> *"[h] the photodiodes of the second set of photodiodes are connected to one another in parallel to provide a second signal stream responsive to light from at least one of the one or more light emitters attenuated by body tissue"*

On this record, the cited evidence supports Petitioner's undisputed contention that Mendelson-2003 discloses that each set of photodiodes are connected in parallel to provide a first signal stream and a second signal stream. Pet. 43–48, 50; Ex. 1024, 3017 ("Each cluster of six PDs were wired in parallel and connected through a central hub to the common summing input of a current-to-voltage converter."); *see also* Pet. 41–46 (additional contentions); Ex. 1003 ¶¶ 101–106, 110.

Dr. Kenny testifies that a person of ordinary skill in the art would have known that connecting multiple photodiodes together in parallel allows the current generated by the multiple photodiodes in the first set to be added to one another, thereby resulting in a larger total current akin to what would be generated from a single, large detector. *Id.* ¶ 102. Further, Dr. Kenny testifies that in light of Mendelson-2003's teaching that each cluster of six photodiodes may be wired in parallel and connected through a central hub, a person of ordinary skill in the art would have found that wiring two rings of photodiodes such that each ring of detectors were wired in parallel to be a routine and conventional design choice. *Id.* ¶ 103 ("Mendelson-2003, whose sensitivity-enhancing photodiode arrangement configuration is being used to modify Aizawa, expressly teaches that the photodiodes in each of the two sets (i.e., rings) of photodiodes are connected to one another in parallel, thereby providing a distinct signal stream for each set/ring.").

Petitioner contends that a person of ordinary skill in the art would have recognized that there can be multiple benefits to separately transmitting

signal streams from the near and far detectors. Pet. 45. Petitioner contends a person of ordinary skill in the art would have recognized that "monitoring each signal stream (from each ring of detectors) separately allows the system to determine when the sensor device is so severely located that its position should be adjusted." Pet. 45–46 (citing Ex. 1003 ¶ 104; Ex. 1025, 13:19–30). Petitioner further contends that in the modified Aizawa-Mendelson-2003 system, the inner ring is likely to produce far greater currents compared to the outer ring. Pet. 47. Thus, in certain implementations, it would have been beneficial to keep each ring separately wired and connected to its own amplifier to thereby keep the magnitude of the current signals provided by each ring approximately the same before being combined and transmitted to the arithmetic circuit. Pet. 47–48; Ex. 1003 ¶ 106 (explaining that "if all the photodiodes in both the first and second rings in the modified Aizawa's sensor device are connected together in parallel . . . signals detected by the near/first sets of detectors may drown out the weaker signals coming from the far/second sets of detectors").

At this stage of the proceeding, Petitioner's stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 101–110.

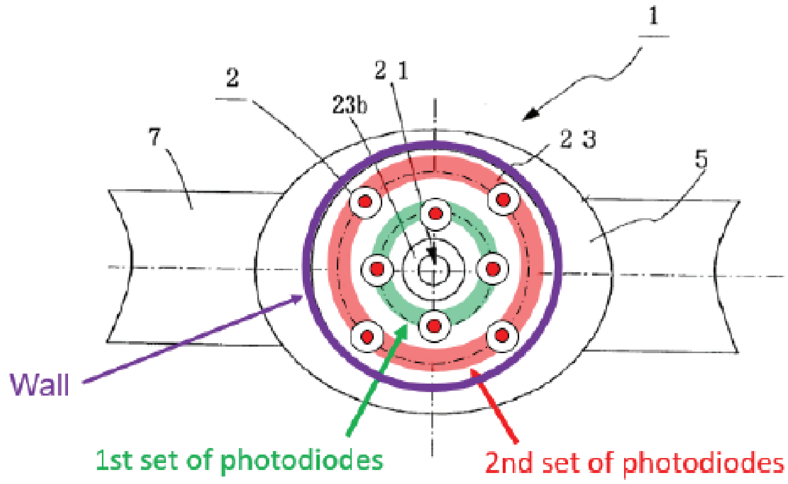
v. "[i] at least one of the first signal stream or the second signal stream includes information usable to determine a physiological parameter of a wearer of the noninvasive physiological parameter measurement device;"

On this record, the cited evidence supports Petitioner's undisputed contention that Aizawa discloses a signal stream usable to determine at least pulse rate. Pet. 43–48, 51. Petitioner contends that "Aizawa teaches that a 'drive detection circuit 24' is used for 'amplifying the outputs [*i.e.*, signal

stream] of the photodetectors' and transmitting the amplified data to the arithmetic circuit 3, which computes the pulse rate, which is a physiological parameter." Pet. 51 (quoting Ex. 1006 ¶¶ 23, 28) (citing Ex. 1003 ¶ 111 ("Because the signal stream from Aizawa's detectors can be used to calculate pulse rate, it represents information usable to determine a physiological parameter of a wearer of the noninvasive physiological parameter measurement device.")).

vi. "[j] a wall extending from the surface and configured to surround at least the first and second sets of photodiodes; and"

On this record, the cited evidence also supports Petitioner's contention that Aizawa discloses a wall that surrounds the photodiodes, including the second set as suggested by the combined teachings of Aizawa and Mendelson-2003. Pet. 51–52; *see, e.g.*, Ex. 1006 ¶ 23 ("holder 23 for storing" LED 21 and detectors 22), Fig. 1(b) (depicting periphery of holder 23 surrounding the sensor components, including detectors 22, which are positioned on a surface); Ex. 1003 ¶¶ 100–102, 112. Petitioner contends that "[t]he outer periphery of Aizawa's holder 23 provides a circular wall (purple) that surrounds at least the first and second sets of photodiodes," and provides an annotated version of Aizawa's Figure 1(a), which is reproduced below.



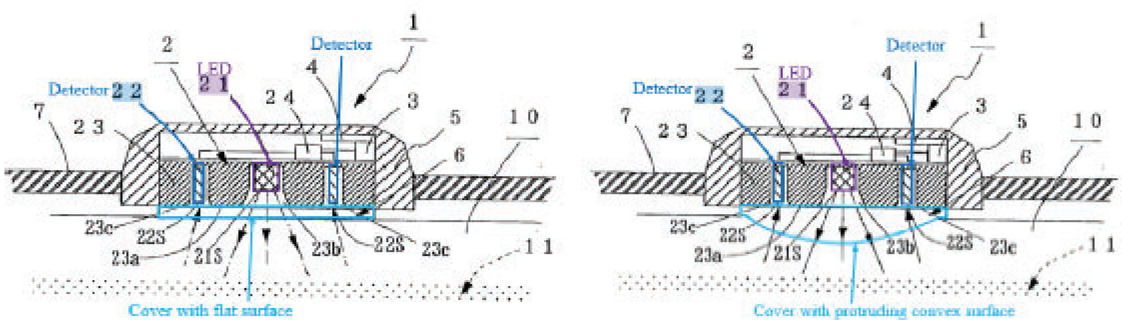
Petitioner's modified and annotated Figure 1(a) of Aizawa depicts a wall (purple) surrounding both the first set of photodiodes and the second set of photodiodes. Pet. 52. Petitioner likewise contends that the identified wall extends from the surface of the substrate. *Id.*

vii. "[k] a cover arranged to cover at least a portion of the surface of the substrate, wherein the cover comprises a protrusion that extends over all of the photodiodes of the first and second sets of photodiodes arranged on the surface, and wherein the cover is further configured to cover the wall."

On this record, the cited evidence supports Petitioner's undisputed contentions regarding this limitation. Pet. 25–31, 52–53. Specifically, Petitioner contends that Aizawa "teaches a light permeable cover in the form of an acrylic transparent plate 6 . . . that is mounted at the detection face 23a" of the sensor, i.e., between the tissue of a user and the photodetectors. Pet. 10–11; Ex. 1003 ¶ 52; Ex. 1006 ¶ 34 ("[A]crylic transparent plate 6 is provided on the detection face 23a of the holder 23 to improve adhesion to the wrist 10."), Fig. 1(b) (depicting flat, transparent plate 6 between sensor 2 and wrist 10). Petitioner also contends that Ohsaki teaches a wrist-worn sensor that includes a "translucent board" having a convex surface that

contacts the user's skin to prevent slippage of the sensor. Pet. 14, 26–27; *see, e.g.*, Ex. 1014 ¶¶ 16 ("worn on the back side of the user's wrist"), 17 ("convex surface"), 25 ("intimate contact" prevents slippage), Figs. 1–2 (depicting convex translucent board 8 between user's tissue and detector).

Petitioner further contends, with reference to the modified and annotated figures reproduced below, that a person of ordinary skill in the art "would have found it obvious to modify [Aizawa's] sensor's flat cover (left) to include a lens/protrusion (right), similar to Ohsaki's translucent board 8, so as to improve adhesion between the user's wrist and the sensor's surface, improve detection efficiency, and protect the elements within the sensor housing." Pet. 28–29; *see, e.g.*, Ex. 1003 ¶¶ 79–80.



Petitioner's modified and annotated figures depict Aizawa's sensor as shown in Figure 1(b), modified to include a convex cover. Pet. 29; *see, e.g.*, Ex. 1014 ¶¶ 18 (explaining that outside disturbance light is prevented from penetrating the translucent board because "the surface of the translucent board 8 is in intimate contact with the surface of the user's skin"), 25 ("[Due to the] convex surface . . . the variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin is suppressed [and] [i]t is also prevented that noise such as disturbance light from the outside penetrates the translucent board 8. Therefore, the pulse

wave can be detected without being affected.”); Ex. 1003 ¶¶ 77, 80; *see also* Pet. 26–29 (discussing further motivation and reasoning). Petitioner contends that, in the combination, the cover would extend over all of the photodiodes. Pet. 53; Ex. 1003 ¶¶ 114–115.

Petitioner also contends that combining these teachings “would have amounted to nothing more than the use of a known technique to improve similar devices in the same way.” Pet. 29; *see, e.g.*, Ex. 1003 ¶ 80. Petitioner contends that “the elements of the combined system would each perform similar functions they had been known to perform prior to the combination—Aizawa-Mendelson-2003’s transparent plate 6 would remain in the same position, performing the same function, but with a convex surface as taught by Ohsaki.” Pet. 29.

At this stage of the proceeding, Petitioner’s stated reasoning for the proposed modification is sufficiently supported, including by the unrebutted testimony of Dr. Kenny. *See, e.g.*, Ex. 1003 ¶¶ 52, 77–80, 114–115.

viii. Summary

For the foregoing reasons, we are persuaded that Petitioner’s cited evidence and reasoning demonstrates a reasonable likelihood that Petitioner would prevail in its contentions regarding claim 1.

6. Claims 2–12 and 14–27

Petitioner presents undisputed contentions that independent claims 14 and 27, and dependent claims 2–12 and 15–26, which depend directly or indirectly from independent claim 1 or 14, are unpatentable over the combined teachings of Aizawa, Mendelson-2003, Ohsaki, and Goldsmith, and provides arguments explaining how the references teach the limitations

of these claims. Pet. 54–84; Ex. 1003 ¶¶ 116–210. Patent Owner does not offer, at this stage, any arguments addressing Petitioner's substantive showing. *See* PO Waiver. Claim 14 is similar to claim 1, but further adds limitations related to "one or more processors." Ex. 1001, 46:33–56; *see also* Pet. 75–76. For reasons substantially similar to those discussed regarding claim 1, we find Petitioner's contentions regarding claim 14 persuasive based on the current record. Pet. 75–76; Ex. 1003 ¶¶ 149–157.

As discussed in detail above, Petitioner has demonstrated a reasonable likelihood of prevailing on the challenge as to claims 1 and 14. Therefore, we institute as to all claims challenged in the petition and on all grounds in the petition. *See* PTAB Consolidated Trial Practice Guide (Nov. 2019) ("Consolidated Guide"),[5] 5–6, 64.

E. Additional Ground

Petitioner provides arguments and evidence, including the Kenny Declaration, in support of Petitioner's additional ground challenging dependent claim 13 of the '366 patent. Pet. 84–88; Ex. 1003 ¶¶ 211–216. Patent Owner does not offer, at this stage, any arguments addressing Petitioner's substantive showing. PO Waiver. We have reviewed these arguments and the cited evidence, and we determine Petitioner has demonstrated a reasonable likelihood of prevailing as to this contention. We institute review of claim 13 based on this ground. *See SAS*, 138 S. Ct. 1348; Consolidated Practice Guide, 5–6, 64.

[5] Available at https://www.uspto.gov/TrialPracticeGuideConsolidated.

III. CONCLUSION

The Supreme Court held that a final written decision under 35 U.S.C. § 318(a) must decide the patentability of all claims challenged in the petition. *See SAS*, 138 S. Ct. 1348. After considering the evidence and arguments presented in the Petition, we determine that Petitioner has demonstrated a reasonable likelihood of success in proving that at least claims 1 and 14 of the '366 patent are unpatentable. Accordingly, we institute an *inter partes* review of all claims and all grounds set forth in the Petition.[6]

At this stage of the proceeding, we have not made a final determination as to the patentability of any challenged claim or as to the construction of any claim term.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 1–27 of the '366 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the '366 patent shall commence on the entry date of this Order, and notice is hereby given of the institution of a trial.

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[6] The Petition addresses the Board's discretion under 35 U.S.C. §§ 314(a) and 325(d). *See* Pet. 88–93. Patent Owner does not argue that we should exercise discretion to deny institution of *inter partes* review. *See* PO Waiver. Accordingly, we do not consider exercising discretion to deny institution of *inter partes* review under 35 U.S.C. §§ 314(a) and 325(d) any further.

FOR PETITIONER:

W. Karl Renner
Roberto J. Devoto
Hyun Jin In
FISH & RICHARDSON P.C.
axf-ptab@fr.com
devoto@fr.com
in@fr.com

FOR PATENT OWNER:

Joseph R. Re
Stephen W. Larson
Jarom D. Kesler
Jacob L. Peterson
KNOBBE, MARTENS, OLSON, & BEAR, LLP
2jrr@knobbe.com
2swl@knobbe.com
2jzk@knobbe.com
2jup@knobbe.com

Filed June 28, 2022

On behalf of:
Patent Owner Masimo Corporation
By: Jarom D. Kesler (Reg. No. 57,046)
Stephen W. Larson (Reg. No. 69,133)
Stephen C. Jensen (Reg. No. 35,556)
Joseph R. Re (Reg. No. 31,291)
Jacob L. Peterson (Reg. No. 65,096)
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
Tel.: (949) 760-0404
Email: AppleIPR2020-1713-564@knobbe.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.

Petitioner,

v.

MASIMO CORPORATION,

Patent Owner.

IPR2020-01713
U.S. Patent 10,624,564

PATENT OWNER'S NOTICE OF APPEAL TO THE U.S. COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Pursuant to 28 U.S.C. § 1295(a)(4)(A), 35 U.S.C. §§ 141(c), 142, and 319, 37 C.F.R. §§ 90.2(a) and 90.3, and Rule 4(a) of the Federal Rules of Appellate Procedure, Patent Owner Masimo Corporation ("Masimo") hereby appeals to the United States Court of Appeals for the Federal Circuit from the Judgment – Final Written Decision (Paper 31) entered on May 2, 2022 (Attachment A) and from all underlying orders, decisions, rulings, and opinions that are adverse to Masimo related thereto and included therein, including those within the Decision Granting Institution of *Inter Partes* Review, entered May 5, 2021 (Paper 7). Masimo appeals the Patent Trial and Appeal Board's determination that claims 1-30 of U.S. Patent 10,624,564 are unpatentable, and all other findings and determinations, including but not limited to claim construction, as well as all other issues decided adverse to Masimo's position or as to which Masimo is dissatisfied in IPR2020-01713 involving Patent 10,624,564.

Masimo is concurrently providing true and correct copies of this Notice of Appeal, along with the required fees, to the Director of the United States Patent and Trademark Office and the Clerk of the United States Court of Appeals for the Federal Circuit.

Case: 22-1972 Document: 31 Page: 231 Filed: 05/01/2023

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: June 28, 2022

/Jarom Kesler/
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

CERTIFICATE OF SERVICE

I hereby certify that the original of this Notice of Appeal was filed via U.S.P.S. Priority Mail Express on June 28, 2022 with the Director of the United States Patent and Trademark Office at the address below:

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United States Patent and Trademark Office
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717 Madison Place, N.W.
Washington, DC 20439

(*via CM/ECF – with filing fee*)

Counsel for Petitioner Apple, Inc.
W. Karl Renner
Andrew B. Patrick
patrick@fr.com
Usman A. Khan
khan@fr.com
Fish & Richardson P.C.

Case: 22-1972 Document: 33 Page: 233 Filed: 08/01/2023

3200 RBC Plaza
60 South Sixth Street
Minneapolis, MN 55402
IPR50095-0023IP1@fr.com
PTABInbound@fr.com
Axf-ptab@fr.com

(*via email pursuant to 37 C.F.R. § 42.6(e)*)

Dated: June 28, 2022

/Jarom Kesler/
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

55610770

Filed June 28, 2022

On behalf of:
Patent Owner Masimo Corporation
By: Jarom D. Kesler (Reg. No. 57,046)
Stephen W. Larson (Reg. No. 69,133)
Stephen C. Jensen (Reg. No. 35,556)
Joseph R. Re (Reg. No. 31,291)
Jacob L. Peterson (Reg. No. 65,096)
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
Tel.: (949) 760-0404
Email: AppleIPR2020-1716@knobbe.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.

Petitioner,

v.

MASIMO CORPORATION,

Patent Owner.

IPR2020-01716
U.S. Patent 10,702,194

PATENT OWNER'S NOTICE OF APPEAL TO THE U.S. COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Pursuant to 28 U.S.C. § 1295(a)(4)(A), 35 U.S.C. §§ 141(c), 142, and 319, 37 C.F.R. §§ 90.2(a) and 90.3, and Rule 4(a) of the Federal Rules of Appellate Procedure, Patent Owner Masimo Corporation ("Masimo") hereby appeals to the United States Court of Appeals for the Federal Circuit from the Judgment – Final Written Decision (Paper 35) entered on April 28, 2022 (Attachment A) and from all underlying orders, decisions, rulings, and opinions that are adverse to Masimo related thereto and included therein, including those within the Decision Granting Institution of *Inter Partes* Review, entered May 5, 2021 (Paper 7). Masimo appeals the Patent Trial and Appeal Board's determination that claims 1-30 of U.S. Patent 10,702,194 are unpatentable, and all other findings and determinations, including but not limited to claim construction, as well as all other issues decided adverse to Masimo's position or as to which Masimo is dissatisfied in IPR2020-01716 involving Patent 10,702,194.

Masimo is concurrently providing true and correct copies of this Notice of Appeal, along with the required fees, to the Director of the United States Patent and Trademark Office and the Clerk of the United States Court of Appeals for the Federal Circuit.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: June 28, 2022

/Jarom Kesler/
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

CERTIFICATE OF SERVICE

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Washington, DC 20439

(*via CM/ECF – with filing fee*)

Counsel for Petitioner Apple, Inc.
W. Karl Renner
Andrew B. Patrick
Hyun Jin In
in@fr.com
Daniel D. Smith
Fish & Richardson P.C.

3200 RBC Plaza
60 South Sixth Street
Minneapolis, MN 55402
IPR50095-0025IP1@fr.com
PTABInbound@fr.com
Axf-ptab@fr.com

(*via email pursuant to 37 C.F.R. § 42.6(e)*)

Dated: June 28, 2022

/Jarom Kesler/
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

55611722

Case: 22-1972 Document: 31 Page: 239 Filed: 05/01/2023

Filed June 28, 2022

On behalf of:
Patent Owner Masimo Corporation
By: Jarom D. Kesler (Reg. No. 57,046)
Stephen W. Larson (Reg. No. 69,133)
Stephen C. Jensen (Reg. No. 35,556)
Joseph R. Re (Reg. No. 31,291)
Jacob L. Peterson (Reg. No. 65,096)
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
Tel.: (949) 760-0404
Email: AppleIPR2020-1733@knobbe.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.

Petitioner,

v.

MASIMO CORPORATION,

Patent Owner.

IPR2020-01733
U.S. Patent 10,702,195

PATENT OWNER'S NOTICE OF APPEAL TO THE U.S. COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Pursuant to 28 U.S.C. § 1295(a)(4)(A), 35 U.S.C. §§ 141(c), 142, and 319, 37 C.F.R. §§ 90.2(a) and 90.3, and Rule 4(a) of the Federal Rules of Appellate Procedure, Patent Owner Masimo Corporation ("Masimo") hereby appeals to the United States Court of Appeals for the Federal Circuit from the Judgment – Final Written Decision (Paper 33) entered on April 28, 2022 (Attachment A) and from all underlying orders, decisions, rulings, and opinions that are adverse to Masimo related thereto and included therein, including those within the Decision Granting Institution of *Inter Partes* Review, entered May 5, 2021 (Paper 7). Masimo appeals the Patent Trial and Appeal Board's determination that claims 1-17 of U.S. Patent 10,702,195 are unpatentable, and all other findings and determinations, including but not limited to claim construction, as well as all other issues decided adverse to Masimo's position or as to which Masimo is dissatisfied in IPR2020-01733 involving Patent 10,702,195.

Masimo is concurrently providing true and correct copies of this Notice of Appeal, along with the required fees, to the Director of the United States Patent and Trademark Office and the Clerk of the United States Court of Appeals for the Federal Circuit.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: June 28, 2022

/Jarom Kesler/
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

CERTIFICATE OF SERVICE

I hereby certify that the original of this Notice of Appeal was filed via U.S.P.S. Priority Mail Express on June 28, 2022 with the Director of the United States Patent and Trademark Office at the address below:

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Counsel for Petitioner Apple, Inc.
W. Karl Renner
Andrew B. Patrick
Hyun Jin In
in@fr.com
Daniel D. Smith
Fish & Richardson P.C.

3200 RBC Plaza
60 South Sixth Street
Minneapolis, MN 55402
IPR50095-0026IP1@fr.com
PTABInbound@fr.com
Axf-ptab@fr.com

(*via email pursuant to 37 C.F.R. § 42.6(e)*)

Dated: June 28, 2022

/Jarom Kesler /
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

55611920

Filed June 28, 2022

On behalf of:
Patent Owner Masimo Corporation
By: Jarom D. Kesler (Reg. No. 57,046)
Stephen W. Larson (Reg. No. 69,133)
Stephen C. Jensen (Reg. No. 35,556)
Joseph R. Re (Reg. No. 31,291)
Jacob L. Peterson (Reg. No. 65,096)
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
Tel.: (949) 760-0404
Email: AppleIPR2020-1737@knobbe.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.

Petitioner,

v.

MASIMO CORPORATION,

Patent Owner.

IPR2020-01737
U.S. Patent 10,709,366

PATENT OWNER'S NOTICE OF APPEAL TO THE U.S. COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Pursuant to 28 U.S.C. § 1295(a)(4)(A), 35 U.S.C. §§ 141(c), 142, and 319, 37 C.F.R. §§ 90.2(a) and 90.3, and Rule 4(a) of the Federal Rules of Appellate Procedure, Patent Owner Masimo Corporation ("Masimo") hereby appeals to the United States Court of Appeals for the Federal Circuit from the Judgment – Final Written Decision (Paper 33) entered on May 4, 2022 (Attachment A) and from all underlying orders, decisions, rulings, and opinions that are adverse to Masimo related thereto and included therein, including those within the Decision Granting Institution of *Inter Partes* Review, entered May 12, 2021 (Paper 7). Masimo appeals the Patent Trial and Appeal Board's determination that claims 1-27 of U.S. Patent 10,709,366 are unpatentable, and all other findings and determinations, including but not limited to claim construction, as well as all other issues decided adverse to Masimo's position or as to which Masimo is dissatisfied in IPR2020-01737 involving Patent 10,709,366.

Masimo is concurrently providing true and correct copies of this Notice of Appeal, along with the required fees, to the Director of the United States Patent and Trademark Office and the Clerk of the United States Court of Appeals for the Federal Circuit.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: June 28, 2022

/Jarom Kesler/
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

CERTIFICATE OF SERVICE

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(*via CM/ECF – with filing fee*)

Counsel for Petitioner Apple, Inc.
W. Karl Renner
Andrew B. Patrick
Hyun Jin In
in@fr.com
Daniel D. Smith
Fish & Richardson P.C.

3200 RBC Plaza
60 South Sixth Street
Minneapolis, MN 55402
IPR50095-0027IP1@fr.com
PTABInbound@fr.com
Axf-ptab@fr.com

(*via email pursuant to 37 C.F.R. § 42.6(e)*)

Dated: June 28, 2022

/Jarom Kesler/
Jarom D. Kesler (Reg. No. 57,046)

Attorney for Patent Owner
Masimo Corporation

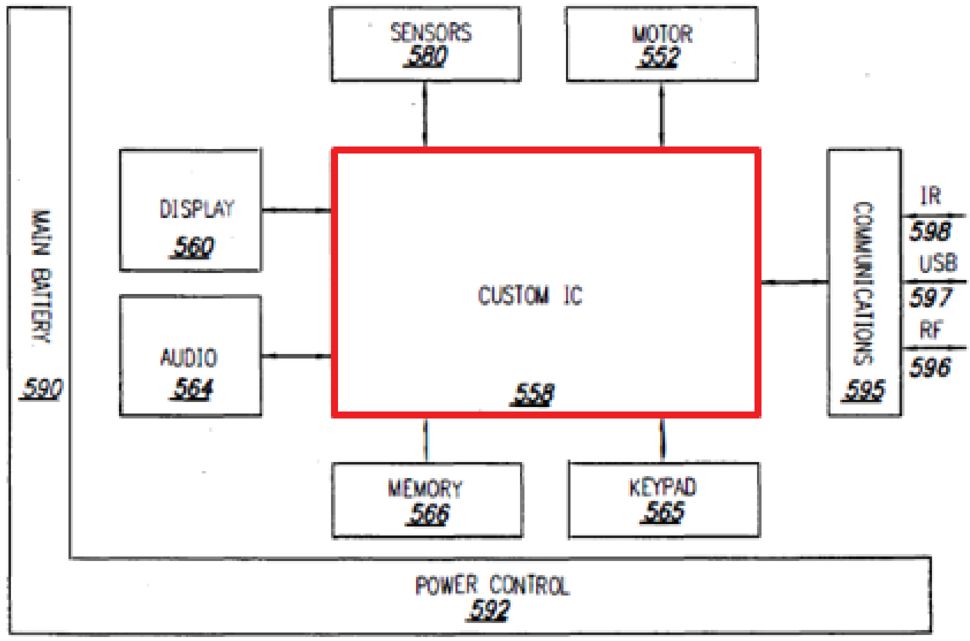
55611997

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Jeroen Poeze et al.	
U.S. Patent No.:	10,624,564	Attorney Docket No.: 50095-0023IP1
Issue Date:	April 21, 2020	
Appl. Serial No.:	16/725,292	
Filing Date:	December 23, 2019	
Title:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

Mail Stop Patent Board
Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT NO. 10,624,564 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42



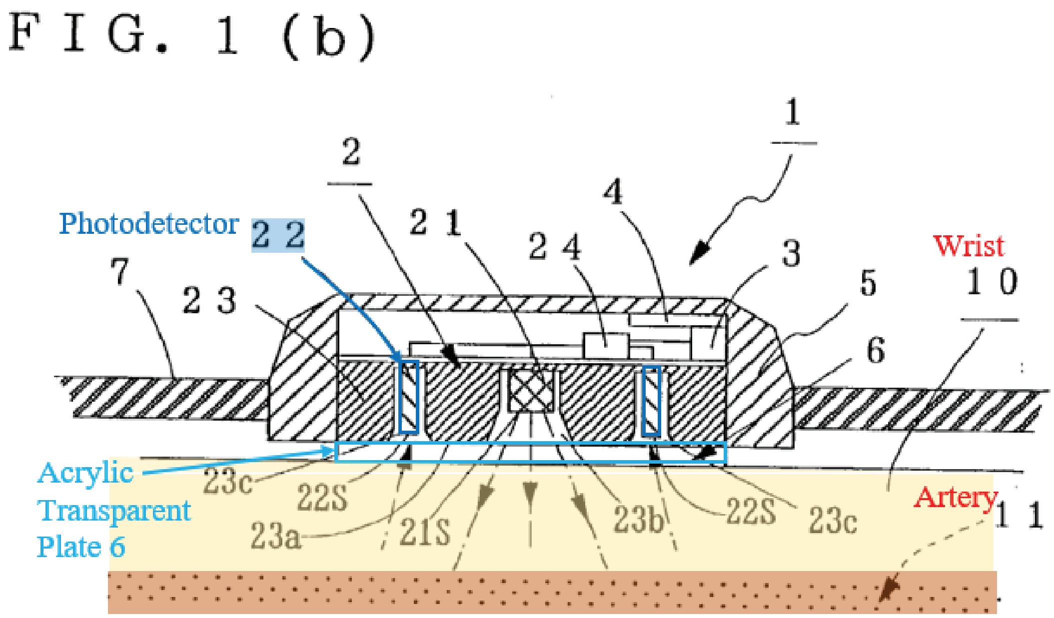
APPLE-1011, FIG. 8.

4. Combination of Aizawa, Ohsaki, and Goldsmith

(a) Aizawa and Ohsaki

Convex surface

Aizawa and Ohsaki are directed to physiological measurement devices ("PMD") that include pulse sensors. APPLE-1006, Abstract, ¶[0002]; APPLE-1009, ¶[0016]. Aizawa's PMD can be worn by a user like a watch including an emitter (LED) facing the user's wrist. APPLE-1006, ¶[0026]; *see supra* Section IV.B.1. Aizawa's sensor has a flat transparent plate 6 that contacts the user's wrist. *Id.*, FIG. 1(b); APPLE-1003, ¶[0066].

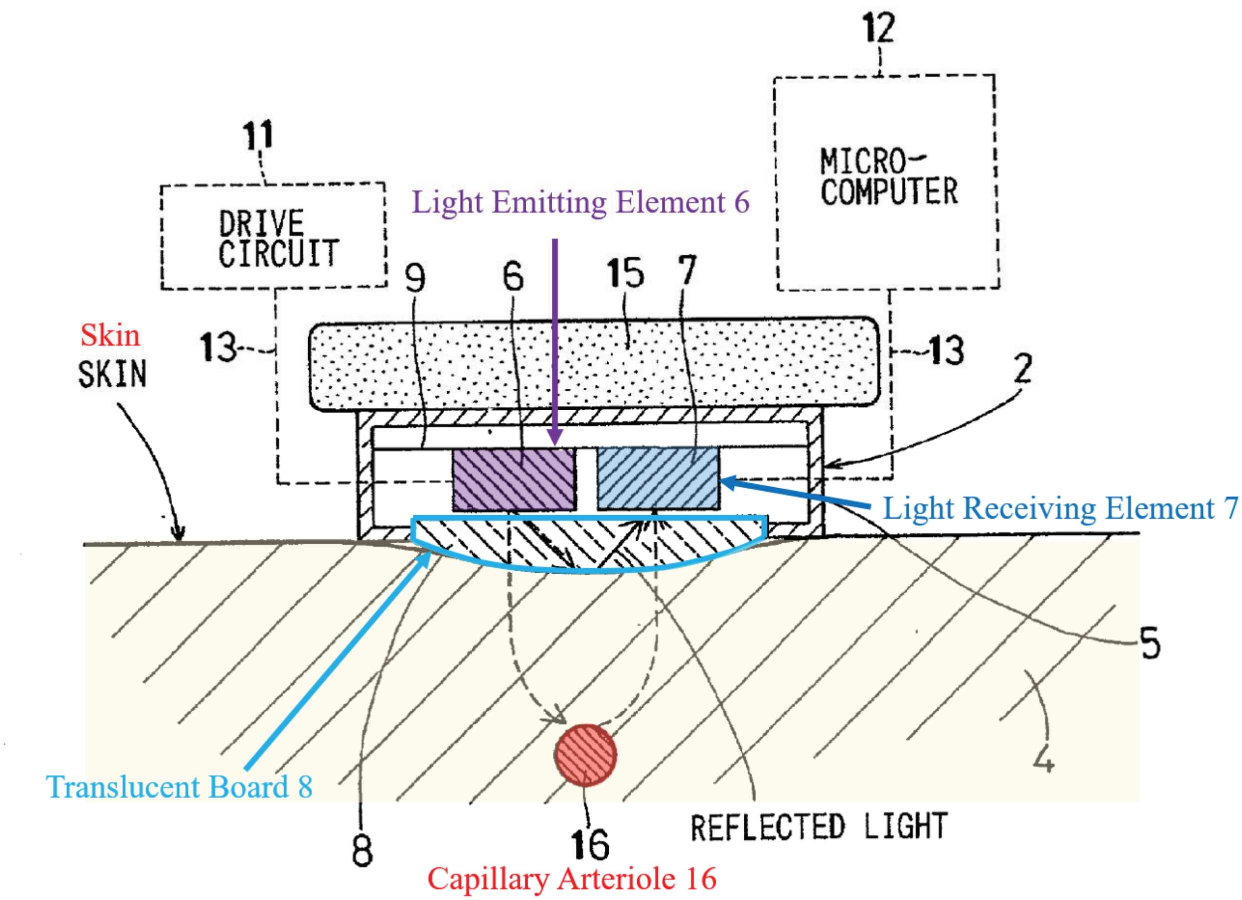


APPLE-1006, FIG. 1(b).

A POSITA would have recognized that with a flat plate 6, Aizawa's wrist-worn PMD would have slipped along the user's wrist, resulting in variations in the light detected by the photodetectors, as explained by Ohsaki. APPLE-1009, ¶[0025]; APPLE-1003, ¶[0067]. Accordingly, a POSITA would have found it obvious to modify Aizawa's sensor to include a cover having a protruding convex surface, improving adhesion between a surface of the sensor and the user's wrist. APPLE-1009, ¶[0025]; APPLE-1003, ¶[0067]. Doing so would have amounted to nothing more than the use of a known technique to improve similar devices in the same way and combining prior art elements according to known methods to yield predictable results. *See KSR v. Teleflex*, 550 U.S. 398, 417 (2007); APPLE-1003, ¶[67].

Ohsaki's translucent board 8 is arranged such that, when Ohsaki's PMD is worn "the convex surface of the translucent board…is in intimate contact with the…user's skin"; this contact prevents slippage, which increases the strength of the obtainable signals. APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1003, ¶[0068].

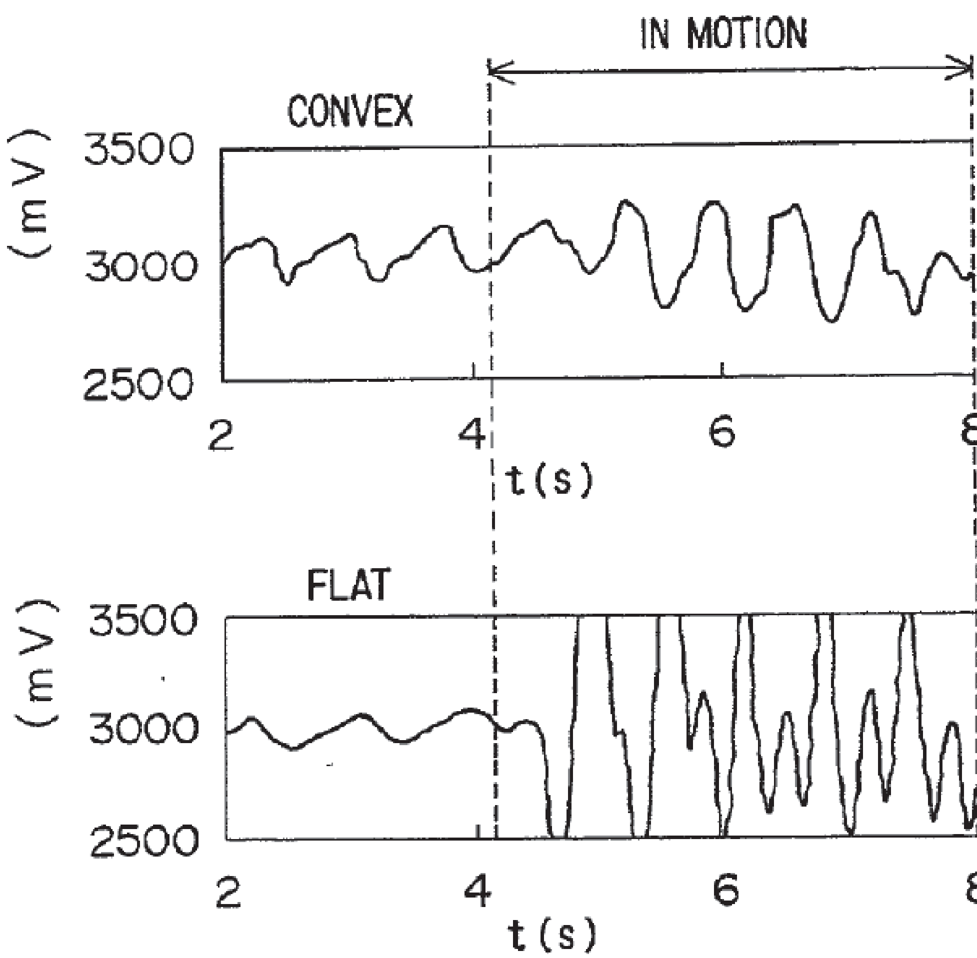
FIG. 2



APPLE-1009, FIG. 2.

Ohsaki explains that "if the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist as

shown in FIG. 4B," but that if "the translucent board 8 has a convex surface…variation of the amount of the reflected light…that reaches the light receiving element 7 is suppressed." APPLE-1009, ¶[0025]. Thus, when a protruding convex cover is used, "the pulse wave can be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A." *Id*.

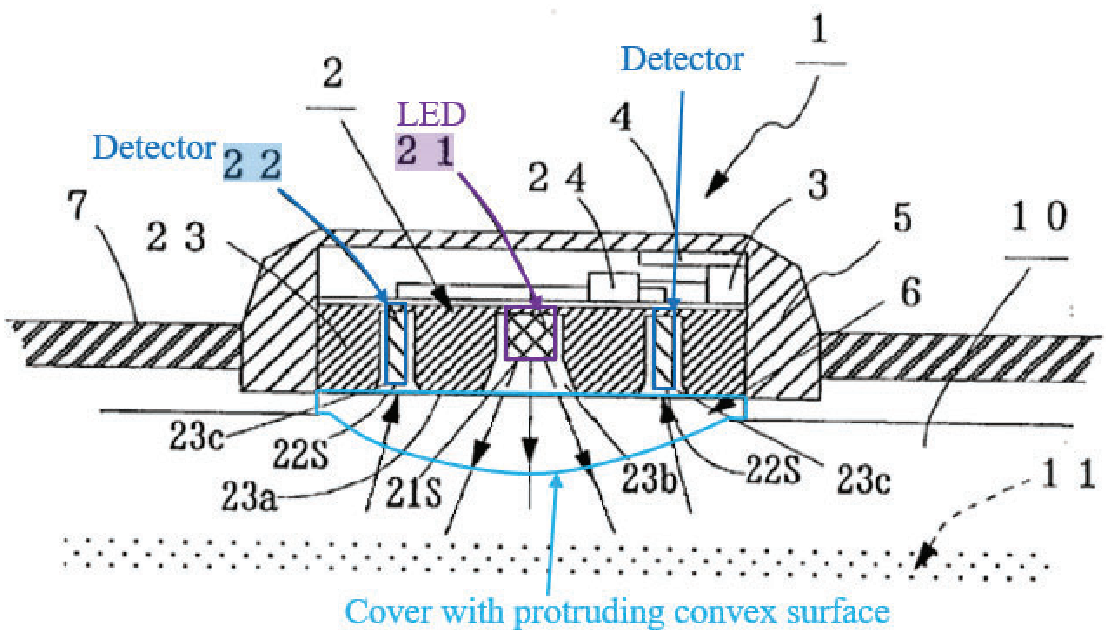


APPLE-1009, FIGS. 4A, 4B.

As shown below, a POSITA would have modified Aizawa's flat cover to in-

clude a protruding convex surface, similar to Ohsaki's, to improve adhesion between the user's wrist and the sensor, improve detection efficiency, and protect the elements within the housing. APPLE-1003, ¶¶[0069]-[0070]; APPLE-1009, ¶[0025]; APPLE-1015, ¶¶[0012], [0024], [0033], [0035], FIG. 6.

FIG. 1 (b)



APPLE-1006, FIG. 1(b) (after modification).

Substrate

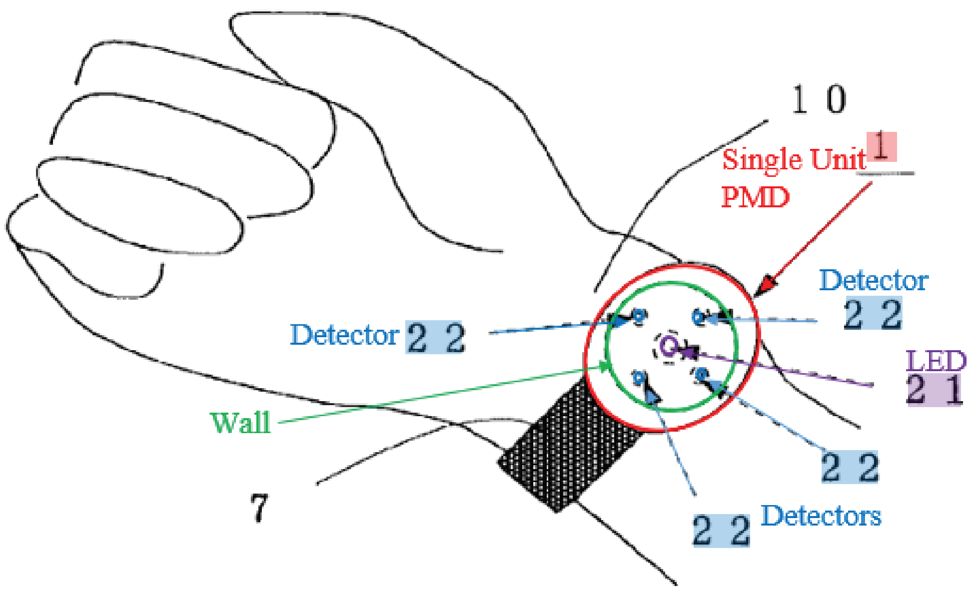
A POSITA would have understood that Aizawa's PMD includes a substrate to accommodate the LED 21 and phototransistors 22. APPLE-1006, ¶ [0023]; APPLE-1003, ¶[0071]. However, to the extent that the Patent Owner contends that

<u>*Claim 6*</u>

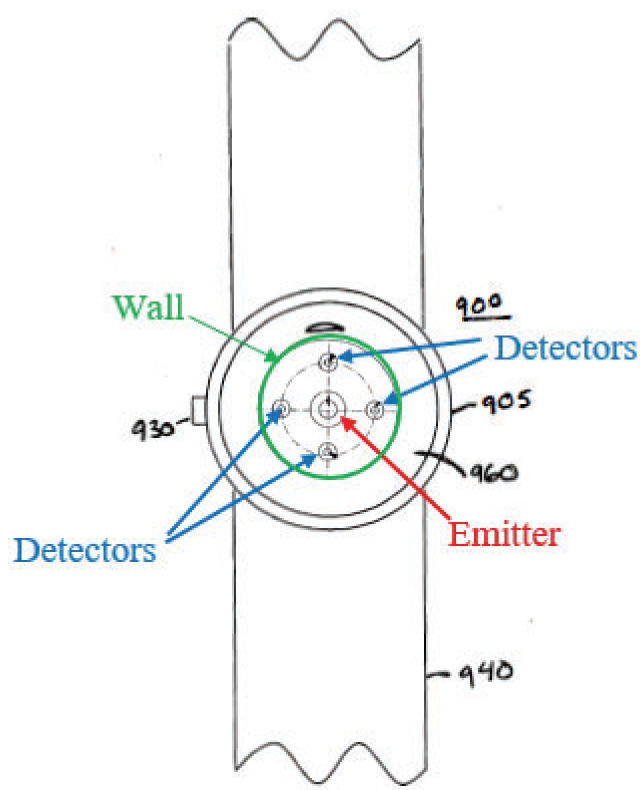
[6] The user-worn physiological measurement device of claim 5, further comprising a single unit wearable by the user, the single unit encompassing the one or more emitters, the at least four detectors, the wall, the cover, the one or more processors, the network interface, and the storage device.

As shown below, and as described above in Section IV.B.4, a POSITA would have incorporated the Aizawa-Ohsaki sensor into Goldsmith's WCD such that the resulting wrist-worn PMD would be a single integrated unit including LED 21 (*see* Section IV.B.5.[1a]), at least four detectors 22 (*see* Section IV.B.5.[1b]), a wall (*see* Section IV.B.5.[1i]), a cover with protruding convex surface (*see* Section IV.B.5.[1c]), one or more processors (*see* Section IV.B.5.[1d]), a network interface (*see* Section IV.B.5.[1e]), and a storage device (*see* Section IV.B.5.[1j]). APPLE-1003, ¶[0134]; APPLE-1006, Abstract, ¶¶[0023], [0026], [0030], FIGS. 1(a), 1(b), 2; APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; APPLE-1011, ¶¶[0085]-[0106], FIGS. 8, 9A, 9B, 10.

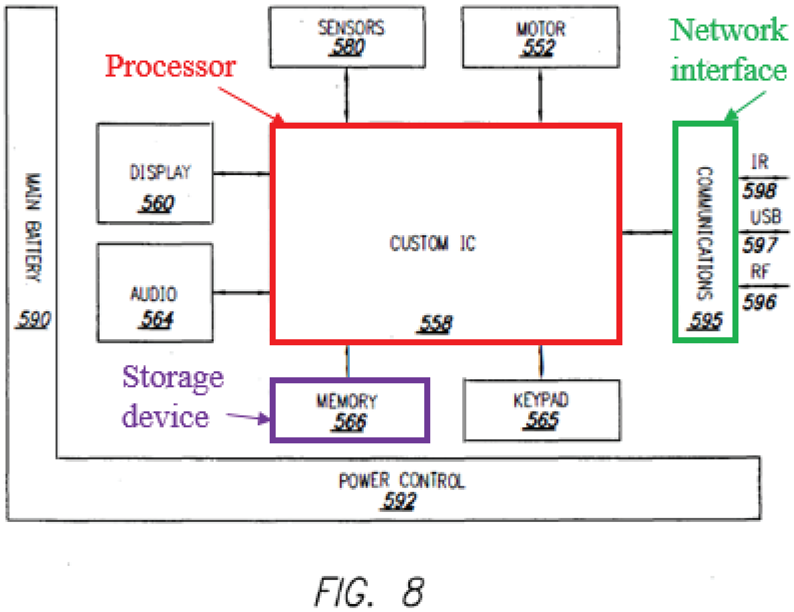
F I G. 2



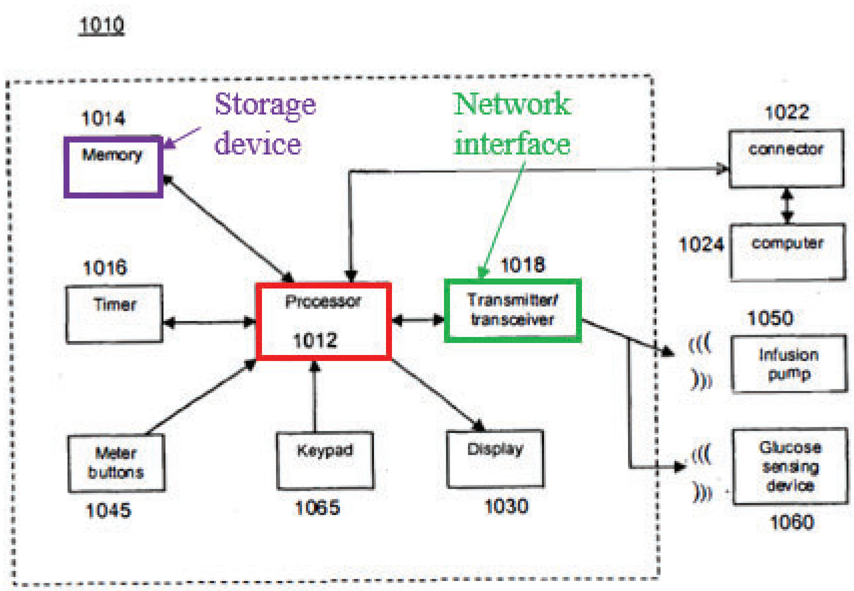
APPLE-1006, FIG. 2.



APPLE-1011, FIG. 9B (modified to include APPLE-1006'S FIG. 1(a)).



APPLE-1011, FIG. 8.



APPLE-1011, FIG. 10.

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On behalf of:
Patent Owner Masimo Corporation
By: Joseph R. Re (Reg. No. 31,291)
Stephen W. Larson (Reg. No. 69,133)
Jarom D. Kesler (Reg. No. 57,046)
Jacob L. Peterson (Reg. No. 65,096)
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
Tel.: (949) 760-0404 Fax: (949) 760-9502
E-mail: AppleIPR2020-1713-564@knobbe.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.

Petitioner,

v.

MASIMO CORPORATION,

Patent Owner.

IPR2020-01713
Patent 10,624,564

PATENT OWNER RESPONSE

Aizawa. Specifically, a POSITA would have credited Ohsaki's guidance that a convex lens/protrusion used on the wrist's palm side "has a tendency to slip." Ex. 1009 ¶[0023], Figs. 3A-3B; Ex. 2004 ¶77.

Accordingly, a POSITA would have come to the opposite conclusion from Petitioner. A POSITA would have believed that modifying Aizawa's flat adhesive plate "to include a protruding convex surface similar to Ohsaki's" would ***not*** "improve adhesion." Pet. 22-23. Indeed, Aizawa and Ohsaki—individually and collectively—rebut Petitioner's unsupported and simplistic assertion that incorporating Ohsaki's ***convex*** surface would "improve adhesion between the user's wrist and the sensor [and] improve detection efficiency." *Id*. 23; Ex. 2004 ¶78. "An inference of nonobviousness is especially strong" where, as here, "the prior art's teachings undermine the very reason being proffered as to why a person of ordinary skill would have combined the known elements." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc*., 567 F.3d 1314, 1326 (Fed. Cir. 2009).

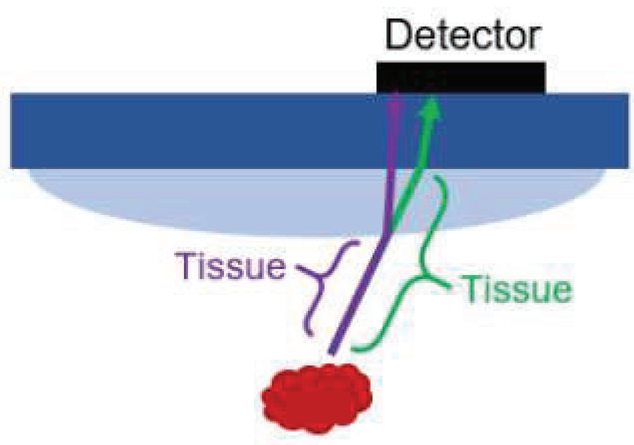
3. A POSITA Would Not Have Been Motivated To Add A Convex Protruding Surface To Aizawa's Sensor Because It Would Have Been Expected To Reduce The Optical Signal

Petitioner's proposed combination also fails because Petitioner detrimentally places a protruding convex surface over peripheral detectors surrounding a centrally located LED. A POSITA would have understood that such a combination would direct light away from the detectors and thus decrease light collection and

optical signal strength—not increase signal strength as Petitioner incorrectly asserts. Ex. 2004 ¶79.

a) <u>A POSITA Would Have Understood That A Convex Cover Directs Light To The Center Of The Sensor</u>

Petitioner and Dr. Kenny both admit that a convex cover condenses light towards the center of the sensor and away from the periphery. Petitioner and Dr. Kenny illustrated this phenomenon in a petition filed against a related patent. In the Petition in IPR2020-01520 (Ex. 2019), Petitioner explained that a convex cover redirects incoming light towards the center, as shown in Petitioner's figure below via the purple arrow, as compared to the direction of light passing through a flat surface (the green arrow):

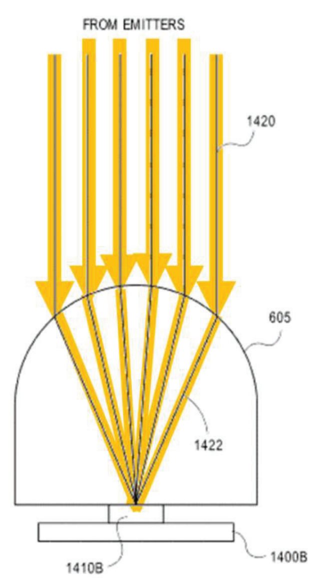


Petitioner's Illustration (Ex. 2019 at 45)

In his declaration in IPR2020-01520 (Ex. 2020), Dr. Kenny confirmed that when using a convex surface as a lens, "the incoming light is 'condensed' ***toward the center***." Ex. 2020 at 69-70; Ex. 2004 ¶¶80-81. Dr. Kenny also confirmed at his

deposition for IPR2020-01520 that the convex surface in his proposed combination would cause "more light in the ***center*** than at the outer edge in this example." Ex. 2006 204:1-13. Dr. Kenny agreed "that's because light's being directed ***towards the center*** and ***away from the edge***…." *Id*. 204:14-20.

The '564 Patent further confirms that a convex surface condenses light away from the periphery and towards the sensor's center. Figure 14B (below) "illustrates how light from emitters (not shown) can be focused by the protrusion 605 onto detectors." Ex. 1001 36:12-15. "When the light rays 1420 enter the protrusion 605, the protrusion 605 acts as a lens to refract the rays into rays 1422." *Id*. 36:23-25. The '564 Patent illustrates that the convex shape directs light from the periphery toward the center. *Id*. Fig. 14B; Ex. 2004 ¶82.

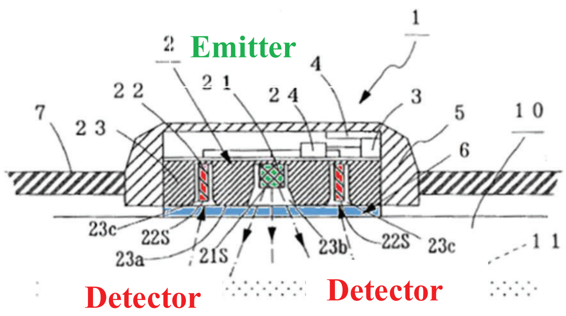


'564 Patent (Ex. 1001) Fig 14B (highlighting added to show direction of light)

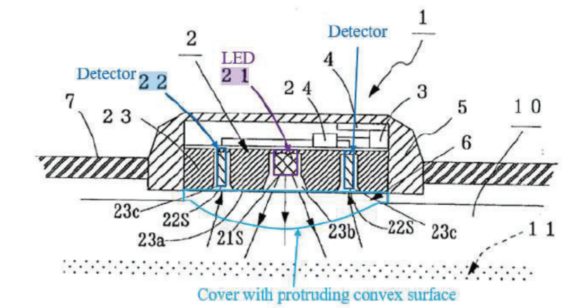
Thus, Petitioner, Dr. Kenny, and the ’564 Patent all support that a POSITA would have understood that a convex lens/protrusion would direct incoming light towards the center of the sensor. This undermines Petitioner’s proposed combination because Aizawa’s detectors are located at the periphery of the sensor, as discussed in more detail below. Ex. 2004 ¶¶80-83.

b) <u>A POSITA Would Not Have Been Motivated To Direct Light Away From Aizawa’s Detectors</u>

Petitioner asserts that a POSITA would have been motivated to modify Aizawa’s flat adhesive acrylic plate with “a protruding convex surface, similar to Ohsaki’s, to … improve detection efficiency. Pet. 22-23. But, as illustrated below (left), Aizawa has peripherally located detectors (in red) and a centrally located emitter (in green). In contrast, Petitioner’s combination introduces a protruding convex surface (in blue, below right) over Aizawa’s peripherally located detectors and centrally located light source (Ex. 2004 ¶84):



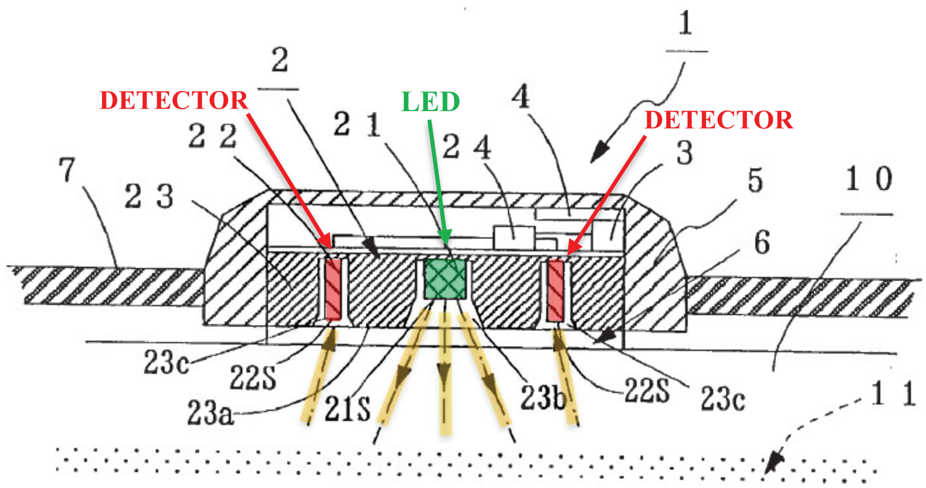
Aizawa Fig. 1B (cross-section)
Red: detectors; Green: emitter,
Blue: flat plate



Petitioner's proposed modifications
(Pet. 23)

Aizawa (Ex. 1006 Fig. 1B) versus Petitioner's combination (Pet. 23)

Petitioner relies on an alleged increase in signal strength as a motivation for this modification. Pet. 15, 21-23 (citing Ex. 1003 ¶¶54, 68-70); Ex. 2004 ¶85. As discussed above, however, a POSITA would have believed that adding a protruding convex surface to Aizawa's flat adhesive acrylic plate would direct light ***away*** from the ***periphery***-located detectors. Ex. 2004 ¶86; *see also id*. ¶¶80-83; *supra* Section VII.B.3.a. The light reaching Aizawa's detectors must travel from the center emitter and eventually reach the detectors at the outer periphery. Ex. 2004 ¶¶85-86. Aizawa illustrates the light path as leaving a single centrally located emitter, passing through the body, and reflecting back to periphery-located detectors (*id*.):

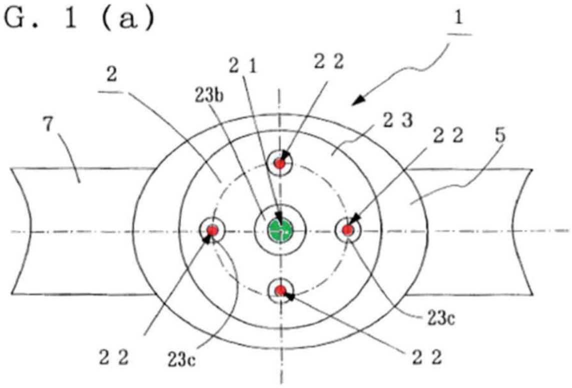


Aizawa Fig. 1B (cross-sectional view, color added)

Accordingly, a POSITA would have believed that a convex surface would have undesirably ***decreased*** light-collection efficiency at Aizawa's peripheral detectors by directing light away from the periphery and towards the center of the sensor, thereby reducing the measured optical signal. Ex. 1006 ¶¶[0026], [0030] (discussing benefits of Aizawa's flat "plate"); Ex. 2004 ¶¶85-86.

Petitioner's combination is particularly problematic because—consistent with Aizawa—Petitioner's combination includes small detectors with small openings surrounded by a large amount of opaque material. Ex. 2004 ¶87. Aizawa's top-down view confirms the small size of Aizawa's detectors. Ex. 1006 Fig. 1A.

FIG. 1 (a)



<u>Aizawa's Features</u>

- **Green**: central emitter (21)
- **Red**: peripheral detectors (22)

Aizawa's sensor, showing small detectors
(Ex. 1006 Fig. 1A, color added)

Dr. Kenny described the difficulty of ensuring light enters these small openings in his deposition for a related IPR proceeding:

> I think one of ordinary skill understands that the holder including the wall, ***everything about the holder is, is made of an opaque material***. That's clearly the intent in Aizawa. He describes rays that, that can reach the detectors if they can ***somehow*** find those tapered openings, but not if they pass-through ***any part*** of this holder so the entire holder is opaque.

Ex. 2006 257:11-18. Thus, Petitioner's and Dr. Kenny's assertion of improved signal strength is not only unsupported by, but contrary to, what a POSITA would have believed would result from adding a convex surface to Aizawa's sensor with its radially arrayed peripheral detectors. Ex. 2004 ¶88.

4. <u>A POSITA Would Not Have Selected A Convex Cover To Protect The Optical Elements</u>

Petitioner also argues that a POSITA would have been motivated "to include a protruding convex surface, similar to Ohsaki's, to…protect the elements within

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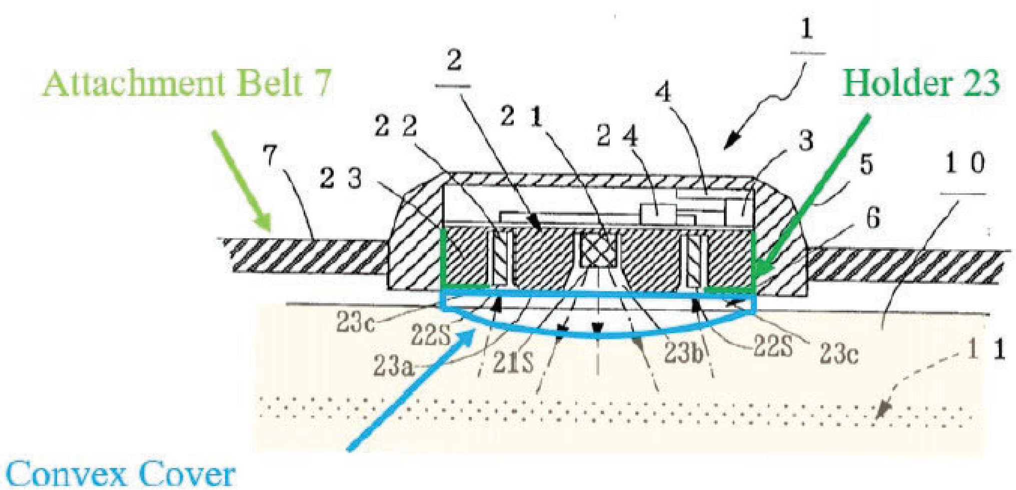
U.S. Patent 10,624,564

PETITIONER'S REPLY TO PATENT OWNER RESPONSE

Aizawa's FIG. 1(b) (reproduced below) shows the results of the proposed combination.



APPLE-1006, FIG. 1(b)

Contrary to Masimo's contentions, the POSITA would have in no way been dissuaded from achieving those benefits by a specific body location associated with Ohsaki's sensor. POR, 25-38; APPLE-1050, ¶¶15-16. Instead, a POSITA would have understood that a light permeable convex cover would have provided the benefits described by Ohsaki in a sensor placed, e.g., on the palm side of the wrist. APPLE-1050, ¶15; APPLE-1009, [0025], Claim 3, FIGS 4A, 4B; APPLE-1021, 91.

For these and other reasons explained below, the Board should reject Masimo's arguments, which avoid addressing the merits of the combinations advanced by Petitioner, and which are grounded in disregard for well-established principles of patent law (e.g., that "***[a] person of ordinary skill is also a person of ordinary creativity, not an automaton***," and that "[t]he test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the

"improv[ing] adhesion between the sensor and the wrist" to "thereby further improve the detection efficiency." APPLE-1006, [0013], [0026], [0030], [0034]; APPLE-1050, ¶29.

Further, the POSITA would have been fully capable of employing inferences and creative steps when improving Aizawa based on Ohsaki's teachings, and would have expected success when applying those teachings. *KSR*, 550 U.S. at 418; *In re Keller*, 642 F.2d 413; APPLE-1050, ¶30. Indeed, a POSITA would have understood that adding a convex protrusion to Aizawa's flat plate would have provided an additional adhesive effect that would have reduced the tendency of that plate to slip. *Id*.

C. Modifying Aizawa's sensor to include a convex cover as taught by Ohsaki enhances the sensor's light-gathering ability

Masimo argues that the combined sensor "would direct light away from the detectors and thus decrease light collection and optical signal strength." POR, 38-39. As explained below, a POSITA would have understood the opposite to be true—that a cover featuring a convex protrusion would improve Aizawa's signal-to-noise ratio by causing more light backscattered from tissue to strike Aizawa's photodetectors than would have with a flat cover. APPLE-1050, ¶31; APPLE-1021, 52, 86, 90; APPLE-1051, 84, 87-92, 135-141; APPLE-1059, 803-805; APPLE-1006, FIGS. 1(a)-1(b). The convex cover enhances the light-gathering ability of Aizawa's sensor.

Against this, Masimo and Dr. Madisetti assert that "a convex surface would…direct[] light away from the periphery and towards the center of the sensor," but, in so doing, fail to articulate a coherent position—e.g., whether Masimo's position is that "all" light or only "some" light is directed "to" or "towards the center." POR, 38-44, Ex. 2004, ¶¶79-88.

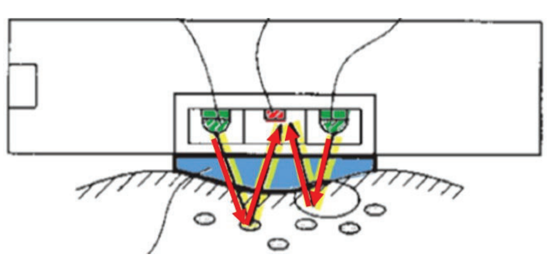
For example, Dr. Madisetti testified during deposition that "as I describe in my Declaration...if you have a convex surface...***all light*** reflected or otherwise would be condensed or directed towards the center." APPLE-1054, 40:4-11; *see also id.*, 127:22-128:18; Ex. 2004, 52 ("A POSITA Would Have Understood That a Convex Cover Directs Light ***To The Center*** Of The Sensor"), ¶¶80-83. However, during the same deposition, Dr. Madisetti further stated that that a convex cover would redirect light "towards the center," which could be "a general area at which the convex surface would be redirecting…light" or "a point," while contrasting the phrase "to the center" from "towards the center." APPLE-1054, 105:12-107:1, 133:19-135:11.

In contrast, and as explained in more detail below, Dr. Kenny has consistently testified that a POSITA would have understood that a convex cover improves "light concentration at pretty much ***all of the locations under the curvature of the lens***," and for at least that reason would have been motivated to modify Aizawa's sensor to include a convex cover as taught by Ohsaki. POR, 39-43; Ex. 2006, 164:8-16; APPLE-1050, ¶¶32-34.

i. Masimo ignores the well-known principle of reversibility

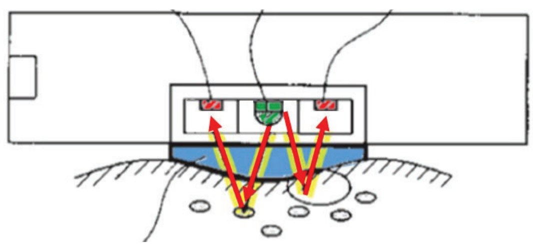
The well-known optical ***principle of reversibility*** dispels Masimo's claim that "a convex cover condenses light towards the center of the sensor and away from the periphery," when applied to Aizawa. POR, 39; APPLE-1051, 87-92; APPLE-1052, 106-111; APPLE-1050, ¶35. According to the principle of reversibility, "a ray going from P to S will trace the same route as one from S to P." APPLE-1051, 92, 84; APPLE-1052, 101, 110; APPLE-1053, 80:20-82:20. Importantly, the principle dictates that rays that are not completely absorbed by user tissue will propagate in a reversible manner. APPLE-1050, ¶35. In other words, every ray that completes a path through tissue from an LED to a detector would trace an identical path through that tissue in reverse, if the positions of the LED emitting the ray and the receiving detector were swapped. APPLE-1050, ¶35; APPLE-1051, 92.

The annotated versions of Inokawa's FIG. 2 presented below together illustrate the principle of reversibility applied in context. As shown, Inokawa's FIG. 2 illustrates two example ray paths from surrounding LEDs (green) to a central detector (red):



APPLE-1007, FIG. 2

As a consequence of the principle of reversibility, a POSITA would have understood that if the LED/detector configuration were swapped, as in Aizawa, the two example rays would travel identical paths in reverse, from a central LED (red) to surrounding detectors (green). APPLE-1050, ¶¶35-36. A POSITA would have understood that, for these rays, any condensing/directing/focusing benefit achieved by Inokawa's cover (blue) under the original configuration would be identically achieved under the reversed configuration:

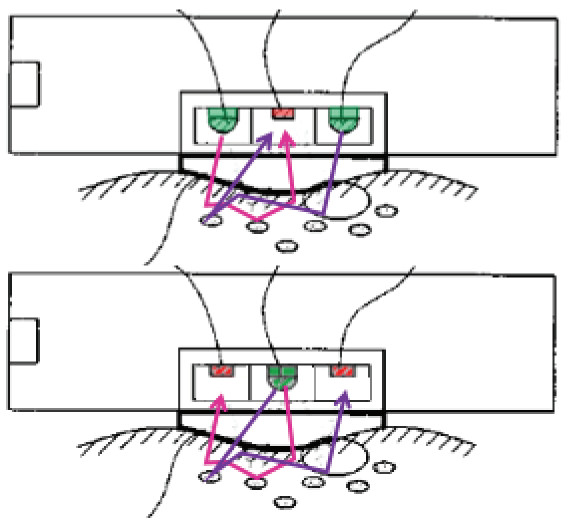


APPLE-1007, FIG. 2

Even when factoring in additional scattering that may occur when light is reflected within human tissue, reversibility holds for each of the rays that are not completely absorbed; consequently, "if we're concerned with the impact of the lens on the system, it's absolutely reversible." APPLE-1055, 209:19-21, 207:9-209:21; APPLE-1050, ¶¶36-43.

In more detail, and as shown with respect to the example paths illustrated below (which include additional scattering within tissue), each of the countless photons travelling through the system must abide by Fermat's principle. APPLE-1050, ¶40; APPLE-1052, 106-111. Consequently, even when accounting for various

random redirections and partial absorptions, each photon traveling between a detector and an LED would take the quickest—and identical—path between those points, even if the positions of the detector and LED were swapped. APPLE-1050, ¶37; APPLE-1055, 207:9-209:21 ("one could look at any particular randomly scattered path…and the reversibility principle applies to all of the pieces [of that path] and, therefore, applies to the aggregate").



When confronted with this basic principle of reversibility during deposition, Dr. Madisetti refused to acknowledge it, even going so far as to express ignorance of "Fermat's principle, ***whatever that is***." APPLE-1054, 89:12-19. Yet Fermat's principle, which states that a path taken by a light ray between two points is one that can be traveled in the least time, is one of the most fundamental concepts in optics/physics and plainly requires the principle of reversibility. APPLE-1051, 87-92; APPLE-1052, 106-111; APPLE-1050, ¶44. Dr. Madisetti tried to brush away the

applicability of this principle as being a "new theory." *Id.*, 84:2- 85:7. But far from being a new theory, this core concept is applied in Aizawa. Indeed, ***Aizawa recognizes such reversibility***, stating that while the configurations depicted include a central emitter surrounded by detectors, the "same effect can be obtained when…a plurality of light emitting diodes 21 are disposed around the photodetector 22." APPLE-1006, [0033]; APPLE-1050, ¶44; APPLE-1055, 209:19-21.

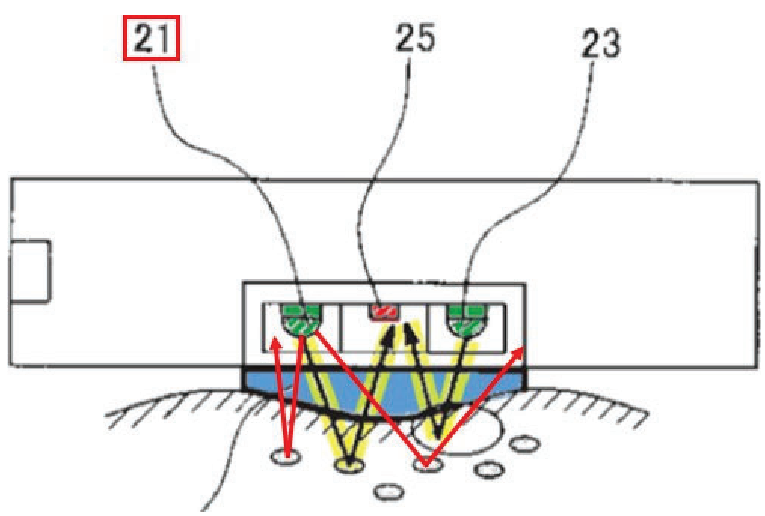
Accordingly, based at least on the principle of reversibility, a POSITA would have understood that configurations of LEDs and detectors would have identically benefitted from the enhanced light-gathering ability of a convex lens/protrusion. APPLE-1050, ¶45.

ii. Masimo ignores the behavior of scattered light in a reflectance-type pulse sensor

Because Aizawa is a reflectance-type pulse sensor that receives diffuse, backscattered light from the measurement site, its cover/lens cannot focus all incoming light toward the sensor's center. APPLE-1050, ¶46; Ex. 2006, 163:12-164:2 ("A lens in general…doesn't produce a single focal point"). Indeed, reflectance-type sensors work by detecting light that has been "partially reflected, transmitted, absorbed, and scattered by the skin and other tissues and the blood before it reaches the detector." APPLE-1021, 86. A POSITA would have understood that light that backscatters from the measurement site after diffusing through tissue

reaches the active detection area from random directions and angles. APPLE-1050, ¶46; APPLE-1056, 803; APPLE-1021, 90, 52.

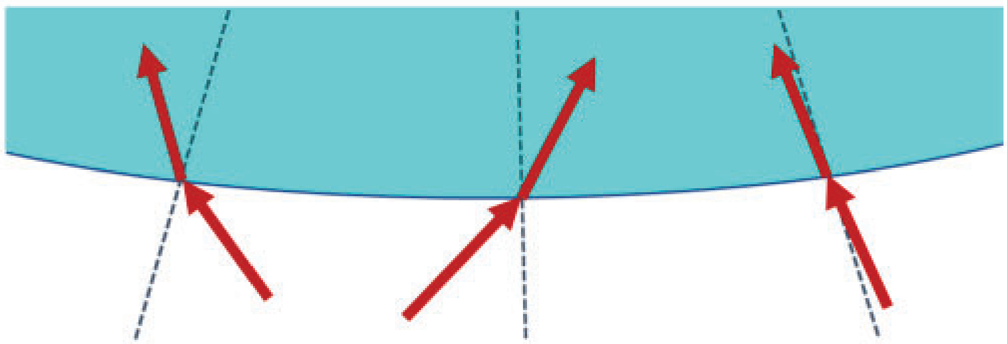
Basic laws of refraction, namely Snell's law, dictate this behavior of light. APPLE-1051, 84; APPLE-1052, 101; APPLE-1053, 80:20-82:20; APPLE-1021, 52, 86, 90; APPLE-1050, ¶¶42-47. For example, referring to Masimo's version of Inokawa's FIG. 2, further annotated below to show additional rays of light emitted from LED 21, it is clearly seen how some of the reflected/scattered light from the measurement site does not reach Inokawa's centrally located detector. APPLE-1050, ¶47.



APPLE-1008, FIG. 2; POR, 14

For these and countless other rays that are not shown, there is simply no way for a cover to focus all light at the center of the sensor device. APPLE-1050, ¶48; APPLE-1051, 84; APPLE-1052, 101; APPLE-1053, 80:20-82:20. Dr. Kenny's illustrative example below shows how Snell's law determines a direction of a

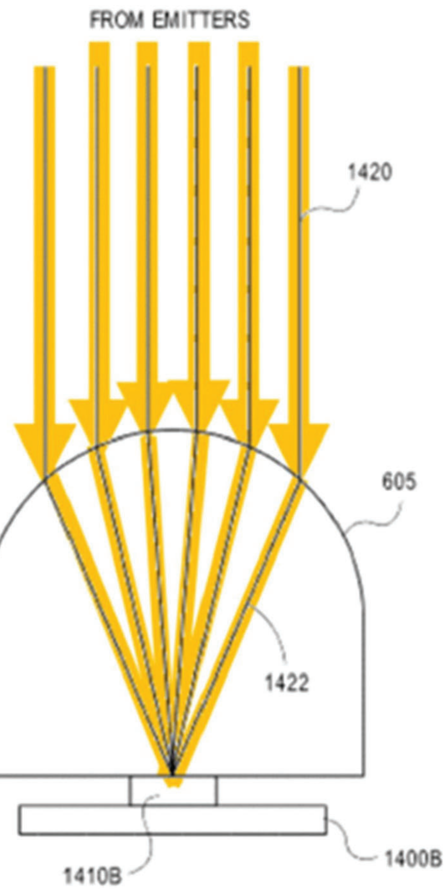
backscattered ray within a convex cover, thus providing a stark contrast to Masimo's assertions that all such rays must be redirected to or towards the center.



APPLE-1050, pp. 29-30

Indeed, far from ***focusing*** light to the center as Masimo contends, Ohsaki's convex cover provides a slight refracting effect, such that light rays that may have missed the detection area are instead directed toward that area as they pass through the interface provided by the cover. APPLE-1050, ¶50. This is particularly true in configurations like Aizawa's in which light detectors are arranged symmetrically about a central light source, so as to enable backscattered light to be detected within a circular active detection area surrounding that source. APPLE-1021, 86, 90. The slight refracting effect is a consequence of the similar indices of refraction between human tissue and a typical cover material (e.g., acrylic). APPLE-1050, ¶49; APPLE-1057, 1486; APPLE-1058, 1484.

Attempting to support its argument that a convex cover focuses all incoming light at the center, Masimo relies heavily on the '553 patent's FIG. 14B (reproduced below):



APPLE-1001, FIG. 14B; POR, 40

Masimo and Dr. Madisetti treat this figure as an illustration of the behavior of all convex surfaces with respect to all types of light, and conclude that "a convex surface condenses light away from the periphery and towards the sensor's center." POR, 40; APPLE-1052, 56:9-60:2; APPLE-1054 ("…a POSA viewing [FIG. 14B]…would understand that light, ***all light***, light from the measurement site is being focused towards the center"). APPLE-1050, ¶51.

But FIG. 14B is not an accurate representation of light that has been reflected from a tissue measurement site. APPLE-1050, ¶52. The light rays (1420) shown in

FIG. 14B are collimated (i.e., travelling paths parallel to one another), and each light ray's path is perpendicular to the detecting surface. *Id*.

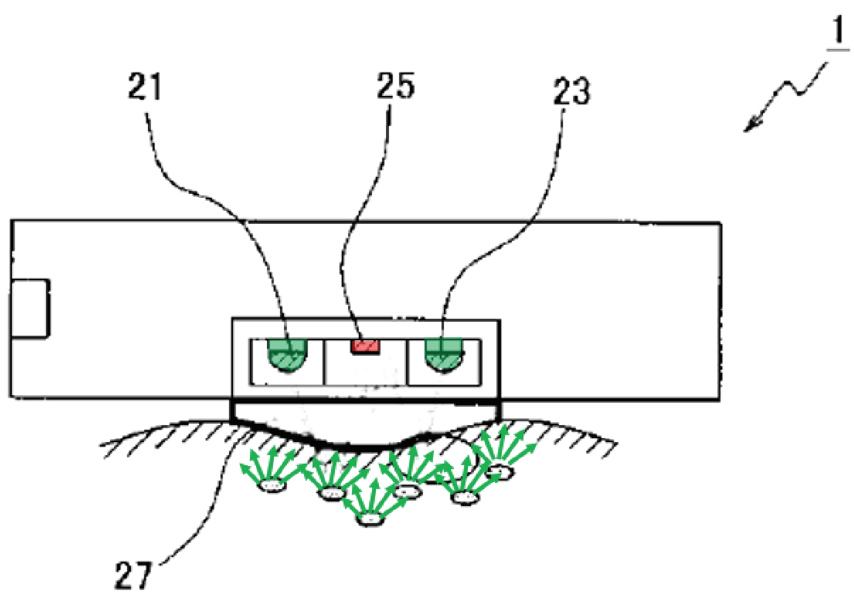
By contrast, the detector(s) of reflectance type pulse detectors detect light that has been "partially reflected, transmitted, absorbed, and scattered by the skin and other tissues and the blood before it reaches the detector." APPLE-1021, 86. For example, a POSITA would have understood from Aizawa's FIG. 1(a) that light that backscatters from the measurement site after diffusing through tissue reaches the circular active detection area provided by Aizawa's detectors from various random directions and angles, as opposed to all light entering from the same direction and at the same angle as shown in FIG. 14B. APPLE-1050, ¶53; APPLE-1021, 52, 86, 90; APPLE-1059, 803-805; *see also* APPLE-1012, FIG. 7.

Even for the collimated light shown in FIG. 14B, the focusing of light at the center only occurs if the light beam also happens to be perfectly aligned with the axis of symmetry of the lens, which does not occur when light reflects off of human tissue. *See* Ex. 2007, 298:11-299:1. And, if for example, collimated light were to enter the FIG. 14B lens at any other angle, the light would focus at a different location in the focal plane.

Further, if the light were not collimated, so that rays enter the lens with a very wide range of incident angles, there would be no focus at all, and many rays will be deflected away from the center. Moreover, since "the center" takes up a very small

portion of the total area under the lens, the majority of rays associated with diffuse light entering the lens would arrive at locations away from the center. APPLE-1050, ¶53. Specifically, the light rays from a diffuse light source, such as the LED-illuminated tissue near a pulse wave sensor or a pulse oximeter, include a wide range of angles and directions, and cannot be focused to a single point/area with optical elements such as lenses and more general convex surfaces.

The example figure below illustrates light rays backscattered by tissue toward a convex lens; as consequence of this backscattering, a POSITA would have understood that the backscattered light will encounter the interface provided by the convex board/lens at all locations from a wide range of angles. APPLE-1050, ¶54. This pattern of incoming light cannot be focused by a convex lens towards any single location. APPLE-1050, ¶54.

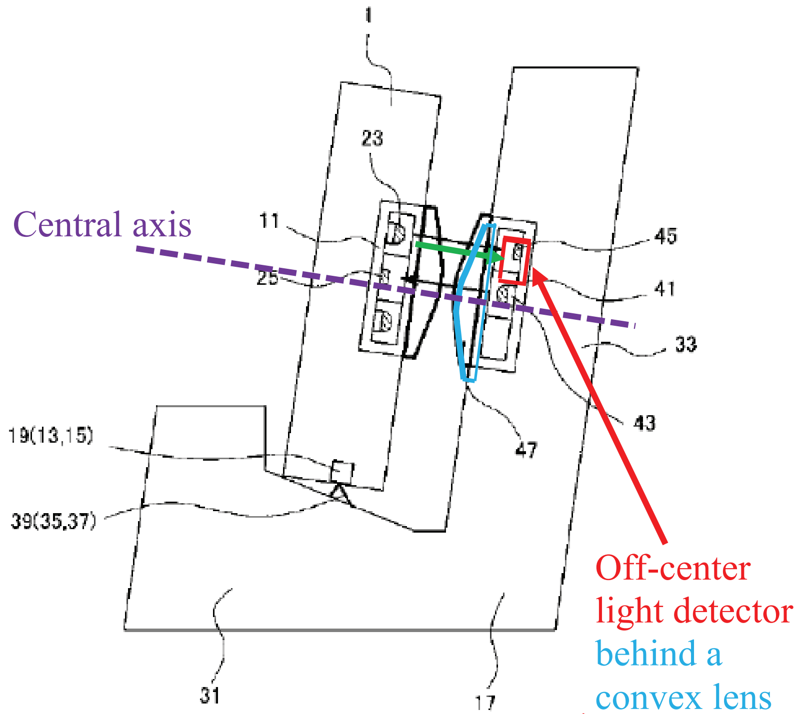


APPLE-1051, 141

To the extent Masimo contends that only *some* light is directed "towards the center" and away from Aizawa's detectors in a way that discourages combination, such arguments fail. Indeed, far from *focusing* light to a single central point, a POSITA would have understood that Ohsaki's cover provides a slight refracting effect, such that light rays that otherwise would have missed the active detection area are instead directed toward that area as they pass through the interface provided by the lens. APPLE-1050, ¶55; APPLE-1021, 52; APPLE-1007, [0015]; APPLE-1051, 87-92, 135-141; APPLE-1054, 60:7-61:6, 70:8-18.

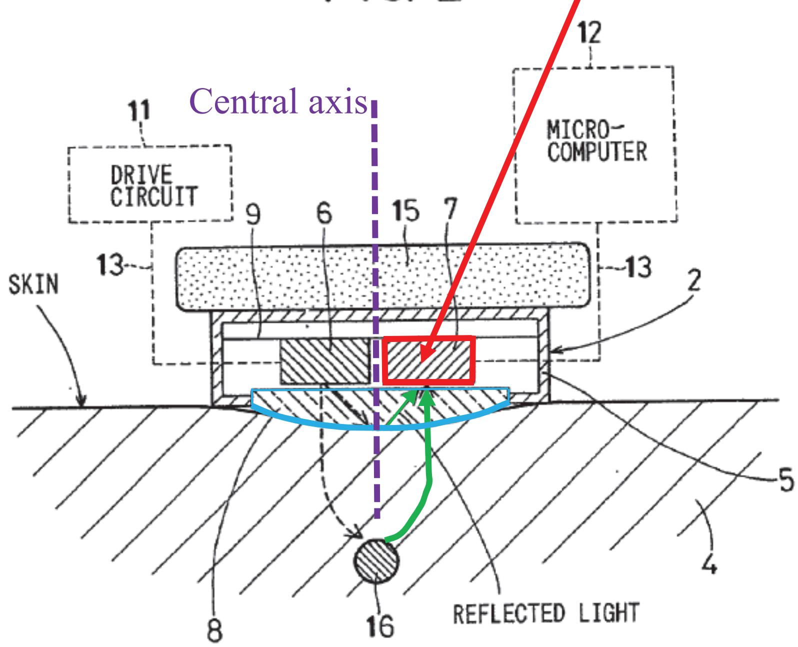
Consistent with that understanding, contrary to Masimo's assertions and as shown below, prior art references, including Ohsaki and Inokawa, demonstrate the use of covers/lenses featuring convex surfaces to direct light to non-centrally located detectors. APPLE-1009, FIG. 2; APPLE-1008, FIG. 3; APPLE-1050, ¶¶56-59.

(FIG. 3)



APPLE-1008, FIG. 3

FIG. 2



APPLE-1009, FIG. 2

Filed December 8, 2021

On behalf of:
Patent Owner Masimo Corporation
By: Joseph R. Re (Reg. No. 31,291)
Stephen W. Larson (Reg. No. 69,133)
Jarom D. Kesler (Reg. No. 57,046)
Jacob L. Peterson (Reg. No. 65,096)
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
Tel.: (949) 760-0404
Fax: (949) 760-9502
E-mail: AppleIPR2020-1713-564@knobbe.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.
Petitioner,

v.

MASIMO CORPORATION,
Patent Owner.

IPR2020-01713
U.S. Patent 10,624,564

PATENT OWNER'S SUR-REPLY TO REPLY

when…a plurality of light emitting diodes 21 are disposed around the photodetector 22." *Id*. (quoting Ex. 1006 ¶[0033]). However, Petitioner's cited paragraph does not even discuss optics. Moreover, Petition points to nothing in its initial papers raising the principle of reversibility. *Id*. 24-25. Petitioner's new theory is improper, denying Masimo the opportunity to respond with expert testimony.

Petitioner's new theory is also irrelevant. Petitioner argues the path of a reflected light ray would trace an identical route forward and backward. Reply 22-23. This argument assumes conditions that are not present when tissue scatters and absorbs light. Even Petitioner admits that tissue randomly scatters and absorbs light rays, which would cause forward and reverse light paths to be unpredictable and very likely different. *See id*. 25-26 (reflectance-type sensors measure "random" light that was "reflected, transmitted, absorbed, and scattered by the skin and other tissues and the blood before it reaches the detector"); Ex. 2027 188:6-17, 29:11-30:7, 31:8-32:3, 38:17-42:6. Petitioner never explains how the principle of reversibility could apply to such "random" scattered and absorbed light.

Indeed, Dr. Kenny testified that "light backscattered from the tissue can go in a large number of possible directions, not any single precise direction." Ex. 2027 17:12-18; *see also id.* 17:19-19:2 (reiterating random path and absorbance), 38:17-40:13, 40:14-42:6 ("Every photon tracing that particular path…would have a

Trials@uspto.gov
571-272-7822

Paper # 30
Entered: 03/15/2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

MASIMO CORPORATION,
Patent Owner.

IPR 2020-01713 (Patent 10,624,564 B1)
IPR 2020-01716 (Patent 10,702,194 B1)
IPR 2020-01733 (Patent 10,702,195 B1)
IPR 2020-01737 (Patent 10,709,366 B1)

Record of Oral Hearing
Held: February 9, 2022

Before JOSIAH C. COCKS, ROBERT L. KINDER, and
AMANDA F. WIEKER, *Administrative Patent Judges.*

Kenny's first declaration testimony we see that Dr. Kenny stated that the person of skill would have taken the user's comfort into consideration and in that regard Ohsaki's convex cover, for example, is said by Ohsaki to solve the problem of the user feeling uncomfortable due to pressure from the device enveloped on the user's lens and there's a citation there to Ohsaki, paragraph 6.

And so in that regard it's worth noting that although the specification of the challenged patents describes an alleged benefit on an order of magnitude, that same specification itself goes on to say that, you know, other considerations might be taken into account. One of those considerations described is user comfort and so it's not saying this is the only way that it could be done and in fact the corroborating evidence supports that the claimed range would have been obvious, you know, for various reasons and in that regard if we were to turn to slide 63 we'll see clippings from --

JUDGE COCKS: Counsel? Counsel, this is Judge Cocks. Before you do that just I want to ask a follow-up question. I see what you reproduced on slide 65 and it does -- the patent does discuss patient comfort as being a consideration but doesn't that suggest that taking patient comfort into consideration or why would that suggest selecting the claimed range of 1 to 3 millimeters which in that same section of the '564 patent provides a benefit, helps signal strength by about an order of magnitude versus other shapes (phonetic)? I guess maybe focus a little bit, what is the significance of taking patient comfort into consideration when it comes to the specific range that is set forth here and claimed?

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 10,624,564 B1
APPLICATION NO. : 16/725292
DATED : April 21, 2020
INVENTOR(S) : Jeroen Poeze

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Item (63), Page 2, Column 1 at Lines 21-22, Related U.S. Application Data, Change "and a continuation-in-part" to --which is a continuation-in-part--.

Item (63), Page 2, Column 1 at Lines 22-23, Related U.S. Application Data, Change "Aug. 25, 2009," to --"Aug. 25, 2008,--.

In the Specification

In Column 38 at Line 34, Change "15008" to --1500B--.

Signed and Sealed this
Second Day of June, 2020

Andrei Iancu
Director of the United States Patent and Trademark Office

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Scott Cromar on 02/20/2020. Amendments were made to better define over the art.

The application has been amended as follows:

Claim 2, line 5, "is above" was replaced by -- extends over --.

2. The following is an examiner's statement of reasons for allowance:

The terminal disclaimer for co-pending applications 16/534,956, 16/544,755, 16/544,713, 16/541,987, 16/534,949, 16/594,980, and 16/725,478 and patent Nos. 10,292,628, 10,299,708, 10,258,266, 10,258,265, 10,376,191, and 10,376,190 was approved on 12/27/2019 for resolving potential double patenting issues.

With regard to the prior art, Chaiken et al. (USPN 6,223,063 - applicant cited) teaches a physiological measurement device (Fig. 1), the physiological measurement device comprising: an emitter configured to emit light into tissue of a user (element 130 and finger, Figs. 1-2); four detectors arranged on a substrate (elements 160 arranged on element 140, Fig. 1); a cover comprising protruding convex surfaces (element 110 with four protrusions 150, Fig. 1), wherein the protruding convex surfaces are above all

of the four detectors (see Fig. 1). Cook et al. (USPGPUB 2002/0111546 - applicant cited) teaches a physiological measurement device (Fig. 7), the physiological measurement device comprising: a plurality of emitters configured to emit light into tissue of a user (element 702, Fig. 7; [0085]); a wall (the side wall(s) of the tubular section(s) connected to the base where the CCD is disposed on, Fig. 7) surrounds at least four detectors (CCD 760, Fig. 7; pixels, [0099]) with pixels; and a cover (window 724, Fig. 7) connects to the wall and the base (Fig. 7) and a computer for image correction, scene segmentation, and blood characteristic analysis ([0044]). Kimura et al. (USPN 6,353,750 - applicant cited) teaches a physiological measurement device (Fig. 27), the physiological measurement device comprising: one or more emitters configured to emit light into tissue of a user (elements 11, Fig. 27); at least four detectors positioned on a detector assembly (a lens with a CCD, a line sensor or a photodiode array of element 12, Fig. 27); a wall that is operably connected to the assembly (element 171, Fig. 27. It appears that the wall is connected to the top portion, e.g. lens of the assembly but not a substrate of the CCD/detector array); and a cover connects the wall (element 170, Fig. 27); the cover comprises a protruding convex surface (element 170, Fig. 27) and at least a portion of the cover is rigid (light-transmitting plate 170 made of acrylic resin, Fig. 27 and associated descriptions) and a personal computer (elements 2, Figs. 1 and 2).

However, the prior art of record does not teach or suggest “at least four detectors arranged on a substrate; a cover comprising a protruding convex surface, wherein the protruding convex surface extends over all of the at least four detectors arranged on the substrate, wherein at least a portion of the protruding convex surface is rigid; a network

interface configured to communicate with a mobile phone; a touch-screen display configured to provide a user interface, wherein: the user interface is configured to display indicia responsive to the measurements of the physiological parameter, and an orientation of the user interface is configurable responsive to a user input; a wall that surrounds at least the at least four detectors, wherein the wall operably connects to the substrate and the cover", in combination with the other claimed elements/steps.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHU CHUAN LIU whose telephone number is (571)270-5507. The examiner can normally be reached on M-Th (8am-6pm).

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jacqueline Cheng can be reached on (571) 272-5596. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Jeroen Poeze, et al.		
U.S. Patent No.:	10,624,564	Attorney Docket No.:	50095-0023IP1
Issue Date:	April 21, 2020		
Appl. Serial No.:	16/725,292		
Filing Date:	December 23, 2019		
Title:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS		

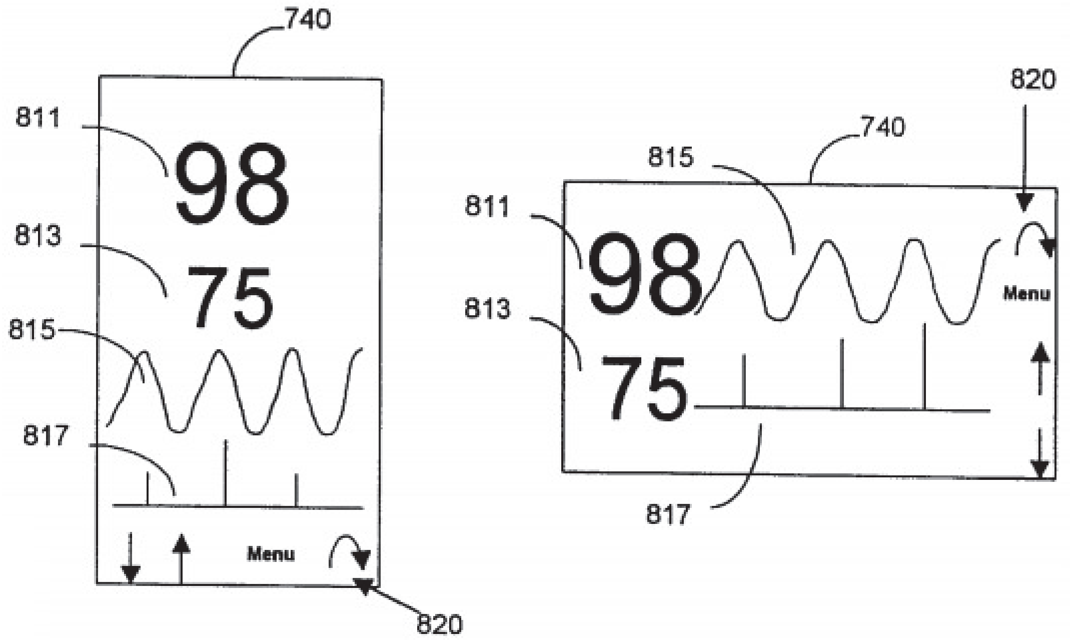
DECLARATION OF DR. THOMAS W. KENNY

I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable under Section 1001 of Title 18 of the United States Code.

By: ______________________________

Thomas W. Kenny, Ph.D.

the x-axis is spread across the display screen over a larger area in FIG. 8C and consequently can be viewed more clearly.



APPLE-1019, FIGS. 8B, 8C.

VII. GROUND 1: Claims 1-10 and 13-30 are obvious over Aizawa, Ohsaki, and Goldsmith

A. Combination of Aizawa, Ohsaki, and Goldsmith

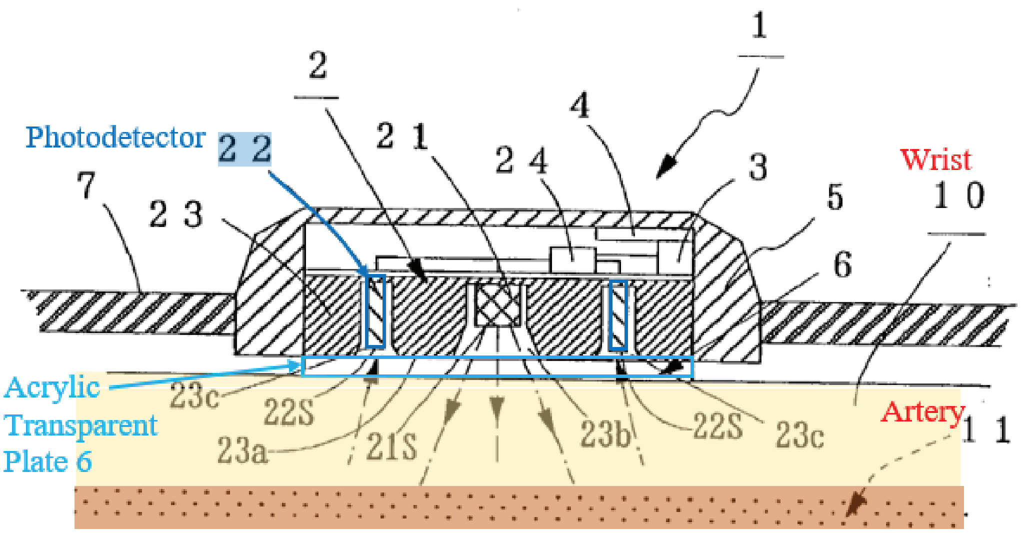
i. *Aizawa and Ohsaki*

Convex surface

66. Aizawa and Ohsaki are directed to physiological measurement devices (PMD) that include pulse sensors. APPLE-1006, Abstract, ¶[0002]; APPLE-1009, ¶[0016]. Aizawa's PMD can be worn by a user like a watch and fastened using an

included belt, with an emitter (LED) facing toward the user's wrist. APPLE-1006, ¶[0026]; *see supra* Section VI.A. Aizawa's sensor has a flat transparent plate 6 that contacts the user's wrist. *Id.*, FIG. 1(b).

FIG. 1 (b)



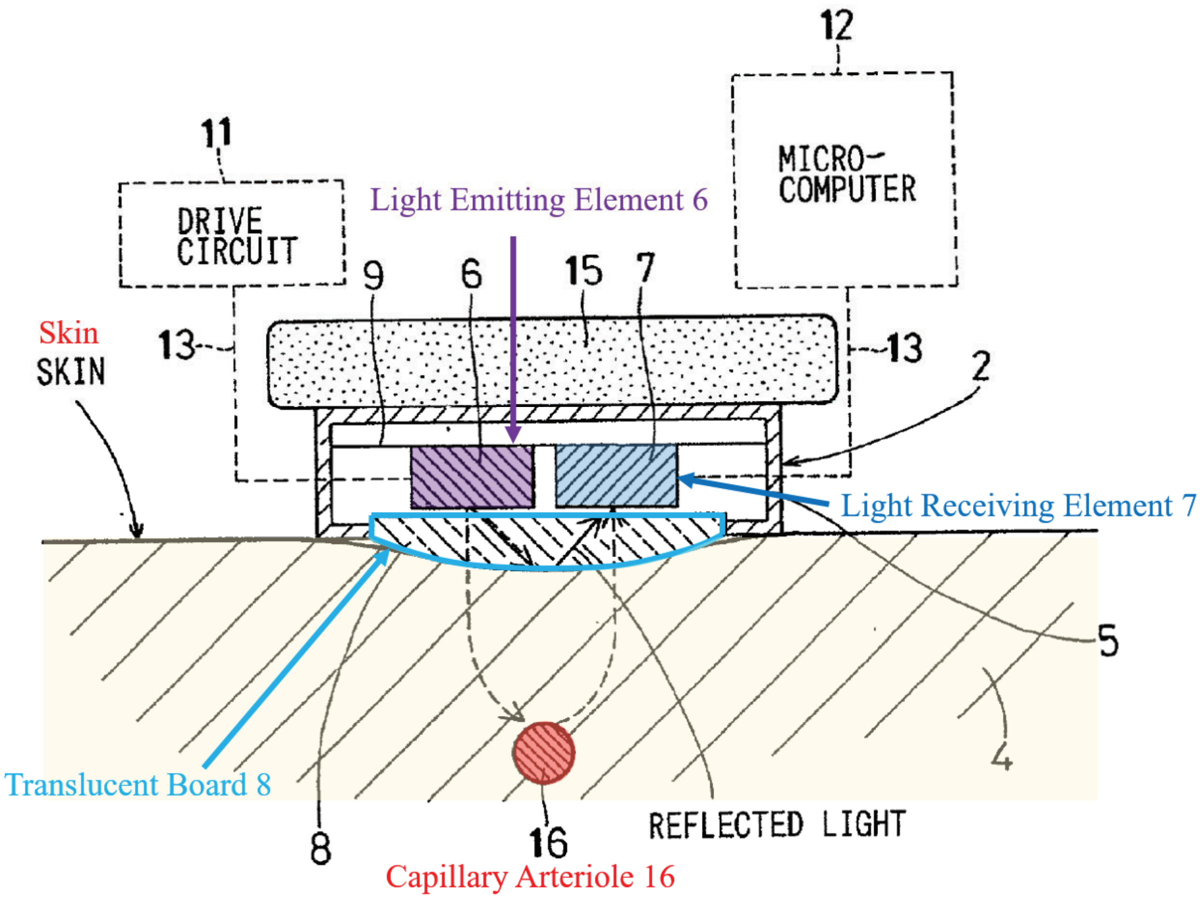
APPLE-1006, FIG. 1(b).

67. A POSITA would have recognized that with a flat plate 6, Aizawa's wrist-worn PMD would have slipped along the user's wrist, resulting in variations in the amount of reflected light that reaches the photodetectors, as explained by Ohsaki. APPLE-1009, ¶[0025]. Accordingly, it would have been obvious to a POSITA to modify Aizawa's sensor to include a cover having a protruding convex surface, improving adhesion between a surface of the sensor and the user's wrist. APPLE-1009, ¶[0025]. Doing so would have amounted to nothing more than the use of a

known technique to improve similar devices in the same way and combining prior art elements according to known methods to yield predictable results.

68. In particular, as shown in Ohsaki's FIG. 2 (reproduced below), Ohsaki's PMD includes "a package 5, a light emitting element 6 (e.g., LED), a light receiving element 7 (e.g., PD), and a translucent board 8." APPLE-1009, ¶[0017]. The translucent board 8 is arranged such that, when the PMD is worn "on the user's wrist…the convex surface of the translucent board…is in intimate contact with the surface of the user's skin"; this contact between the convex surface and the user's skin prevents slippage, which increases the strength of the signals obtainable by Ohsaki's PMD. APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

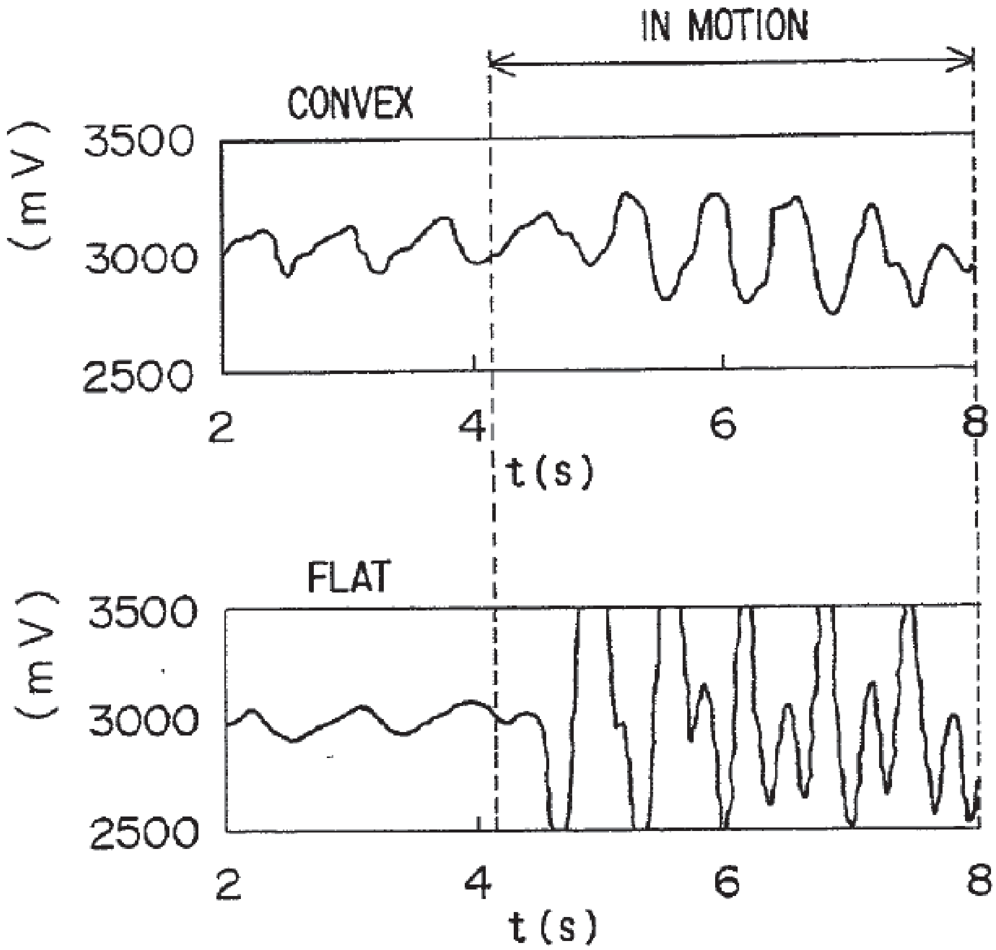
FIG. 2



APPLE-1009, FIG. 2.

69. Ohsaki explains that "if the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist as shown in FIG. 4B," but that if "the translucent board 8 has a convex surface…variation of the amount of the reflected light…that reaches the light receiving element 7 is suppressed." APPLE-1009, ¶[0025]. The convex surface is also said to prevent "disturbance light from the outside" from penetrating translucent board 8. *Id*. Thus, when a protruding convex cover is used, "the pulse

wave can be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A." *Id.*



APPLE-1009, FIGS. 4A, 4B.

70. As shown below, the POSITA would have found it obvious to modify the sensor's flat cover to include a lens/protrusion, similar to Ohsaki's translucent board 8, so as to improve adhesion between the user's wrist and the sensor's surface, improve detection efficiency, and protect the elements within the PMD

housing. APPLE-1009, ¶[0025]; APPLE-1015, ¶¶[0012], [0024], [0033], [0035], FIG. 6 (depicting an LED featuring a convex lens).

FIG. 1 (b)

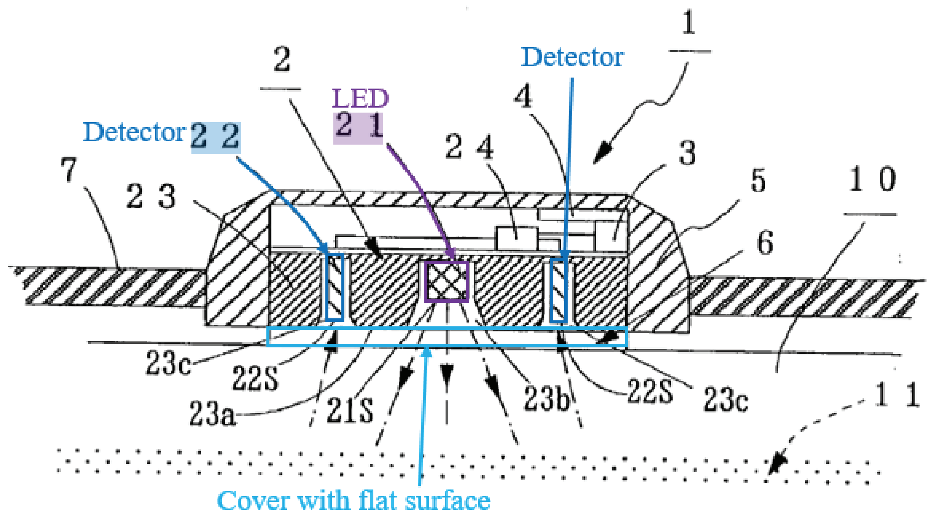
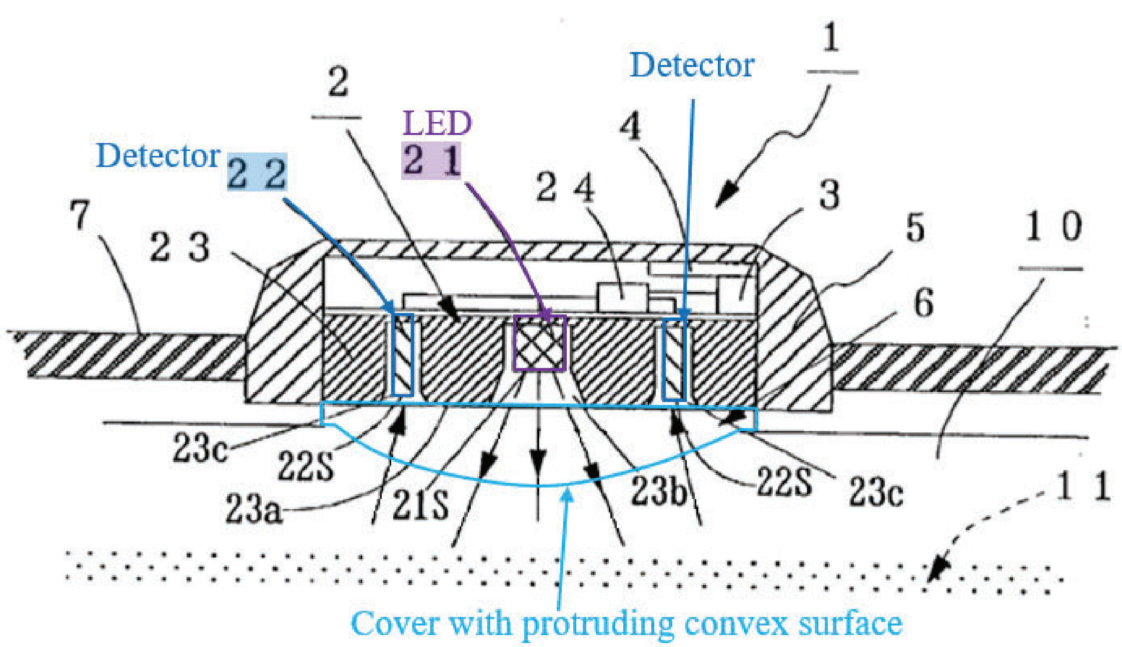


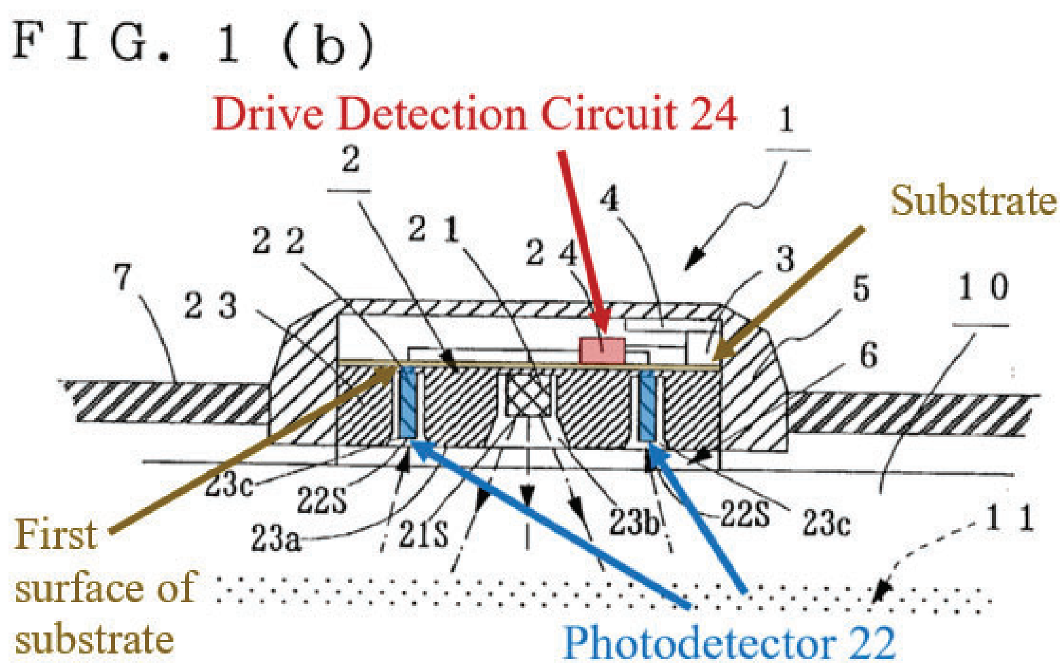
FIG. 1 (b)



APPLE-1006, FIG. 1(b) (top-before modification; bottom-after modification).

Substrate

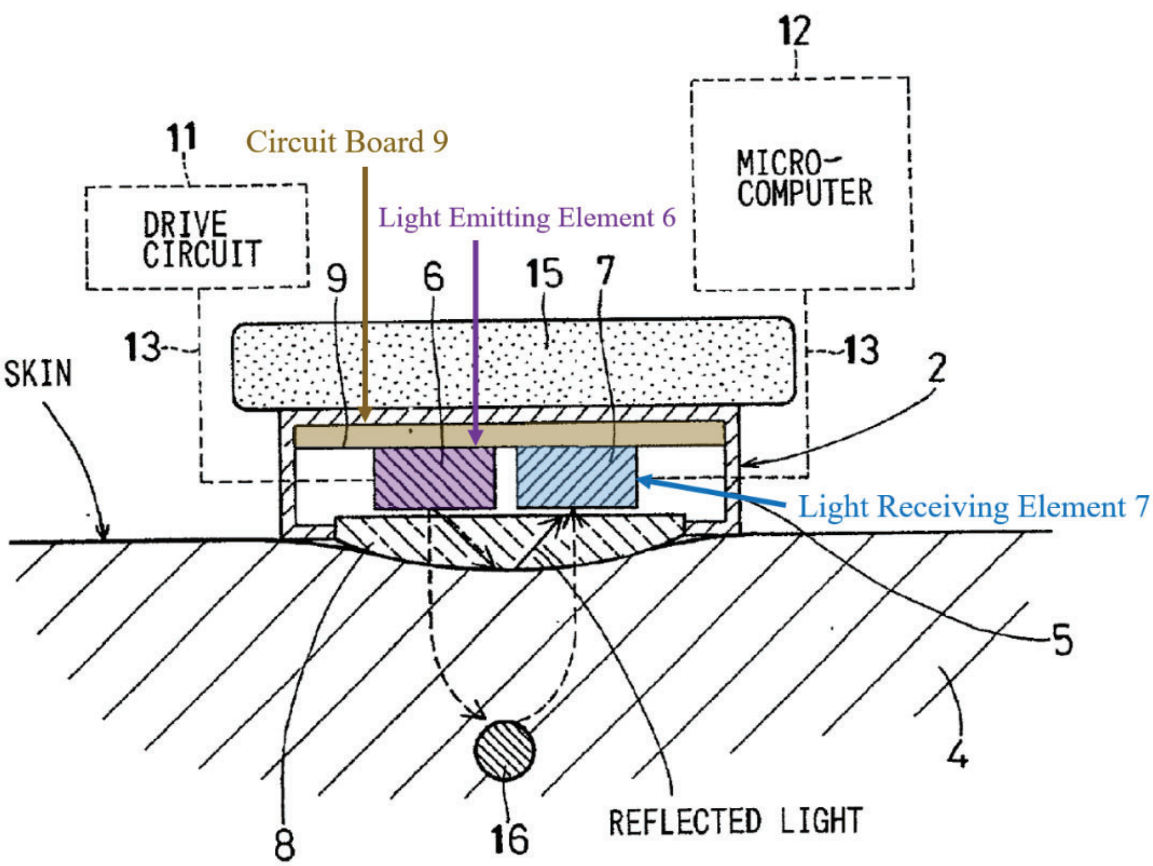
71. A POSITA would have found it obvious that Aizawa's photodetectors are arranged on a substrate. For example, a POSITA would have understood that Aizawa's photodetectors are secured to the PMD, provided with power by a power source (not shown), and can transmit signals to other portions of the PMD through such a structure. A POSITA would have understood that the substrate provides physical support and electrical connectivity and is connected to the holder 23. Indeed, a POSITA would have found it obvious to use such a substrate because it provides a simpler manufacturing process and more compact design than using and routing wires would allow. As shown in FIG. 1(b), Aizawa illustrates a substrate, but does not label or describe such a structure.



APPLE-1006, FIG. 1(b).

72. To the extent that Aizawa does not explicitly disclose a substrate, a POSITA would have been motivated to modify Aizawa to incorporate a substrate, such as Ohsaki's circuit board 9 to secure photodetectors 22 and enable photodetectors 22 to send signals to other portions of the PMD. Doing so would have amounted to nothing more than the use of a known technique to improve similar devices in the same way and combining prior art elements according to known methods to yield predictable results.

FIG. 2



APPLE-1009, FIG. 2.

73. In particular, Aizawa's sensor would have been modified to incorporate Ohsaki's circuit board 9 to enable photodetectors 22 to send signals to other portions of the PMD. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0029], [0032]-[00 33], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶[0017], FIG. 2.

ii. *Aizawa, Ohsaki, and Goldsmith*

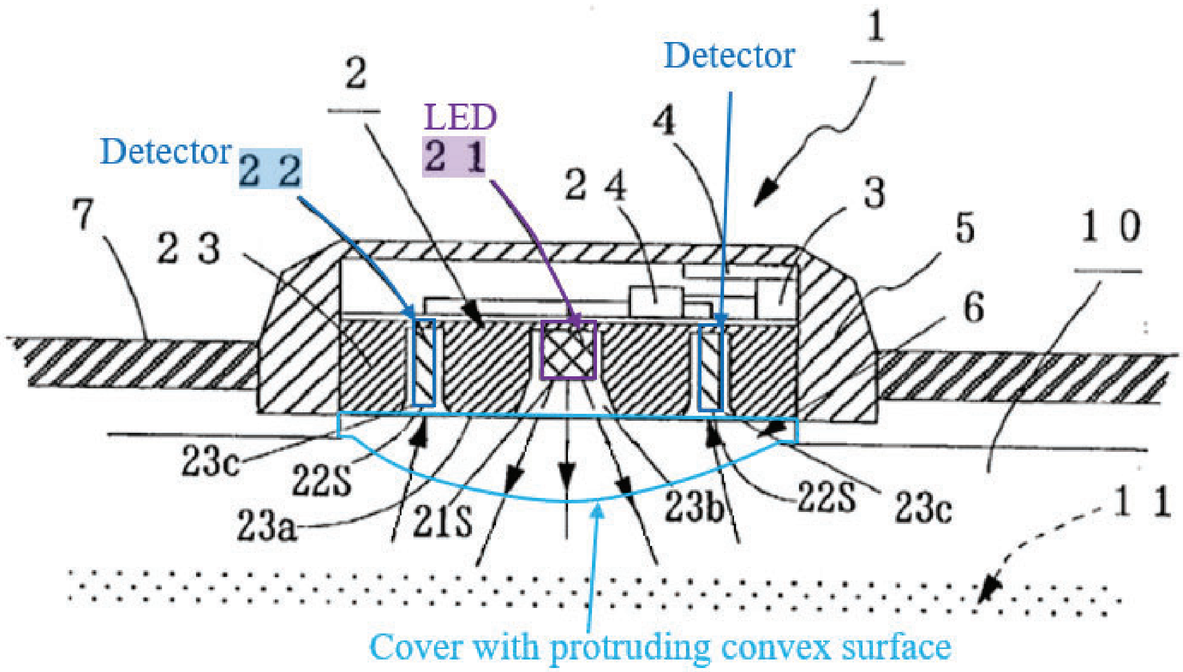
74. Aizawa explains that there is an interest in real-time heart rate measurement "at the time of exercise," and it describes its wrist-worn pulse wave sensor as being "easily attached," and "capable of detecting a pulse wave accurately." APPLE-1006, ¶¶[0004], [0008]. Aizawa goes on to state that its sensor includes "a transmitter for transmitting…pulse rate data to an unshown display," and that it's "pulse rate detector…can be coupled to devices making use of bio signals." APPLE-1006, ¶¶[0023], [0035]. From this and related description, a POSITA would have understood that Aizawa's sensor is capable of transmitting data to a display and/or another device to which that sensor is coupled; further, this and related description would have motivated a POSITA to implement Aizawa's pulse rate sensor as part of a device that can monitor and display heart rate during exercise. APPLE-1006, ¶¶[0004], [0008], [0023], [0026], [0035], FIGS. 1(a), 1(b), 2.

102. The photodetectors 22 are "disposed at an **equal distance** from the light emitting diode." APPLE-1006, ¶¶[0011], [0027]. In addition, for the reasons noted above in Section VII.A.i, it would have been obvious to a POSITA that photodetectors in AOG's PMD are arranged on a substrate. APPLE-1006, Abstract, ¶¶[0002], [0005], [0008]-[0016], [0023], [0027]-[0029], [0032]-[0033], FIGS. 1, 2, 3, 4(a); APPLE-1009, ¶[0017], FIG. 2.

[1c] a cover comprising a protruding convex surface, wherein the protruding convex surface extends over all of the at least four detectors arranged on the substrate, wherein at least a portion of the protruding convex surface is rigid;

103. As explained in Section VII.A.i, AOG's PMD would have included a cover having a protruding convex surface. The protruding convex surface, as shown in Aizawa's modified FIG. 1(b), would have been used to realize improved adhesion between the user's wrist and the sensor's surface, improve detection efficiency, and protect the elements within the sensor housing. APPLE-1009, ¶¶[0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; *see also* APPLE-1006, ¶¶[0012], [0013], [0023], [0024], [0030], FIGS. 1(a), 1(b); APPLE-1015, ¶¶[0033], [0035], FIG. 6; *see supra* Section VII.A.i.

FIG. 1 (b)



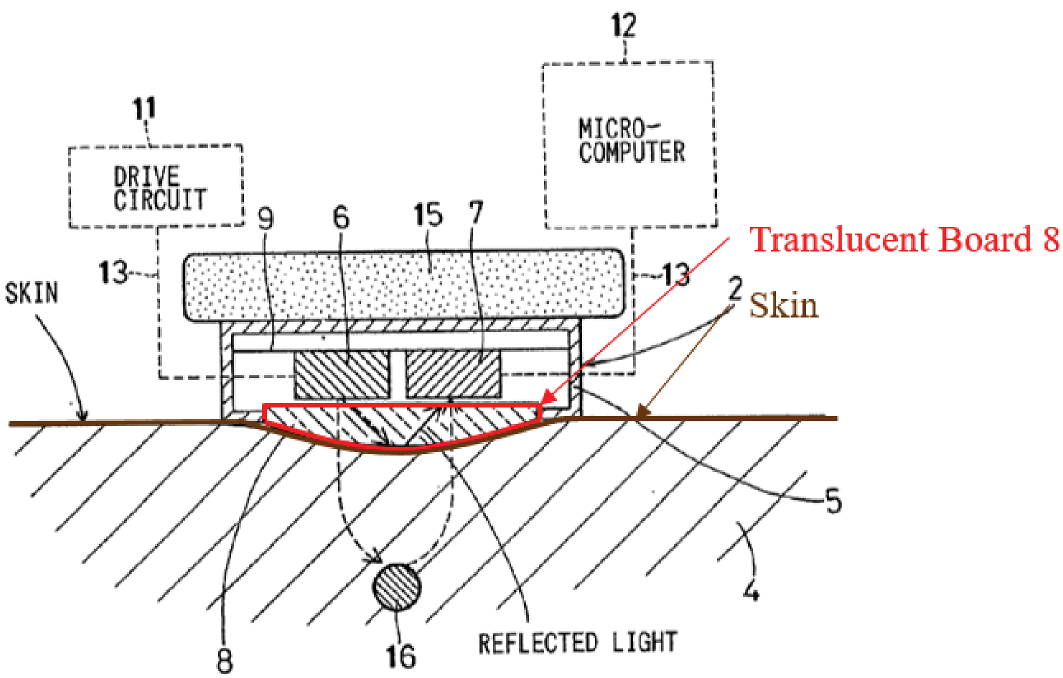
APPLE-1006, modified FIG. 1(b).

104. Ohsaki explains that its convex surface would have been "in intimate contact with the surface of the user's skin" to prevent slippage. APPLE-1009, ¶¶[0009]-[0010]. For example, Ohsaki's FIG. 2 shows a cover in the form of a translucent board 8 with a convex surface that has intimate contact with the user's skin and causes the user's skin to deform. *Id*. A POSITA would have understood that the skin deformation was due to the rigidity of the convex surface.

xv. *Claim 16*

[16] The user-worn physiological measurement device of claim 10, wherein the protruding convex surface protrudes a height between 1 millimeter and 3 millimeters.

146. As noted above in Sections VI.B and VII.A, AOG's PMD includes a protruding convex surface similar to the protruding surface of Ohsaki's cover, which is designed to be "in intimate contact with the surface of the user's skin," to prevent slippage of the detecting element on the user's wrist. APPLE-1009, ¶¶[0009]-[0010], FIG. 2.



APPLE-1009, FIG. 2.

147. In incorporating Ohsaki's teachings, a POSITA would have found it obvious that a device designed to fit on a user's wrist would be on the order of millimeters. *See also* APPLE-1010, 2 (describing its "optical reflectance transducer" as "small

(⌀ = 22mm)"); APPLE-1014, 2 (describing a "standard 24-pin (dimensions: 19 x 19 mm) microelectronic package" for its sensor); APPLE-1023, 9:40-65 (describing a protrusion on a biological measurement device that causes a subject's tissue to deform by a depth of about 2 to 20 mm). Additionally, the POSITA would have taken the user's comfort into consideration—Ohsaki's convex cover, for example, is said to solve the problem of "the user feel[ing] uncomfortable" due to pressure from the device and belt on the user's limbs. APPLE-1009, ¶[0006].

148. A POSITA would have found it obvious that in order to provide a comfortable cover that prevents slippage, the convex surface should protrude a height between 1 millimeter and 3 millimeters. Indeed, there would have been a finite range of possible protruding heights, and it would have been obvious to select a protruding height that would have been comfortable to the user. Accordingly, AOG renders obvious [16].

xvi. *Claim 17*

[17] The user-worn physiological measurement device of claim 16, wherein the protruding convex surface protrudes a height greater than 2 millimeters and less than 3 millimeters.

149. For the reasons noted above in Section VII.B.xv (claim 16), AOG renders obvious [17]. *See supra* Sections VI.B and VII.A.i.

US 20020188210A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2002/0188210 A1
Aizawa (43) Pub. Date: Dec. 12, 2002

(54) PULSE WAVE SENSOR AND PULSE RATE DETECTOR

(76) Inventor: **Nobuyuki Aizawa**, Gunma (JP)

Correspondence Address:
KANESAKA & TAKEUCHI
1423 Powhatan Street
Alexandria, VA 22314 (US)

(21) Appl. No.: **10/152,818**

(22) Filed: **May 23, 2002**

(30) **Foreign Application Priority Data**

Jun. 11, 2001 (JP) 2001-175909

Publication Classification

(51) Int. Cl.[7] **A61B 5/02**
(52) U.S. Cl. **600/503**; 600/502

(57) **ABSTRACT**

A pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject, the sensor comprising four photodetectors disposed around the light emitting diode symmetrically on a circle concentric to the light emitting diode, and a pulse rate detector comprising the pulse wave sensor and means of computing the pulse rate of a subject based on the output of the pulse wave sensor.

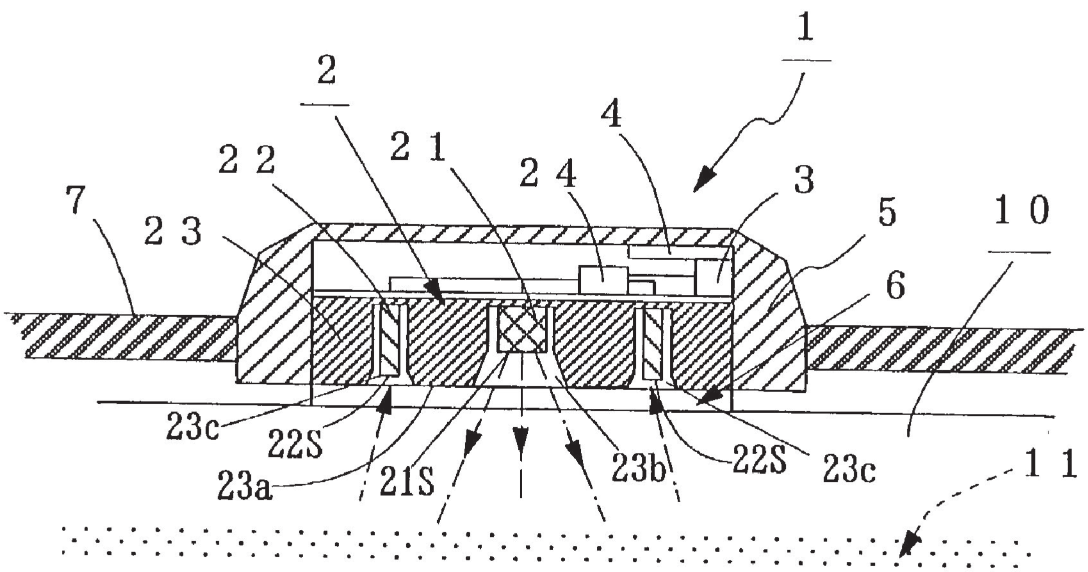
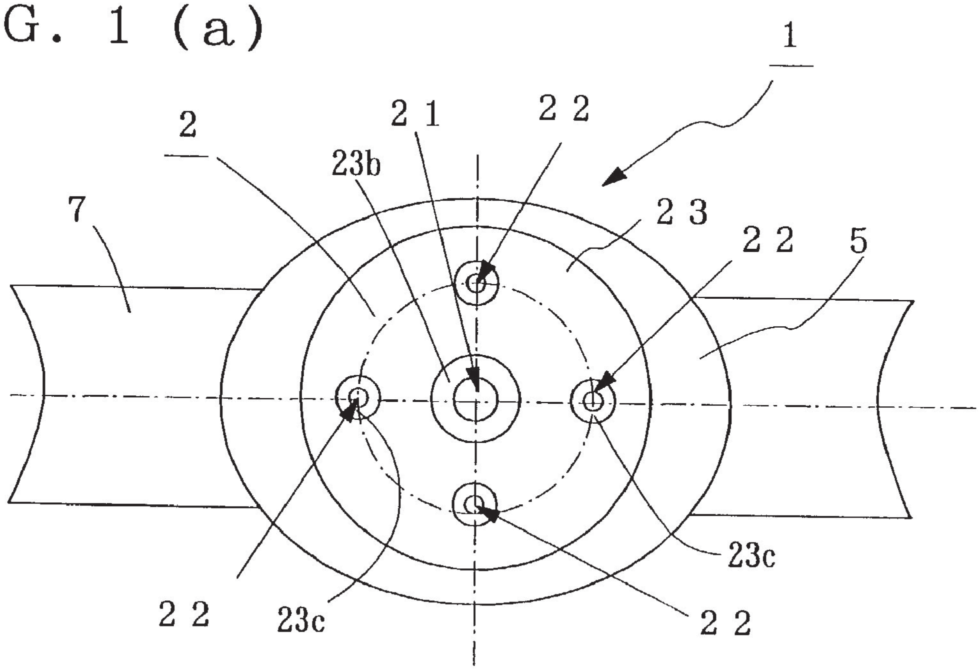


FIG. 1 (a)



1
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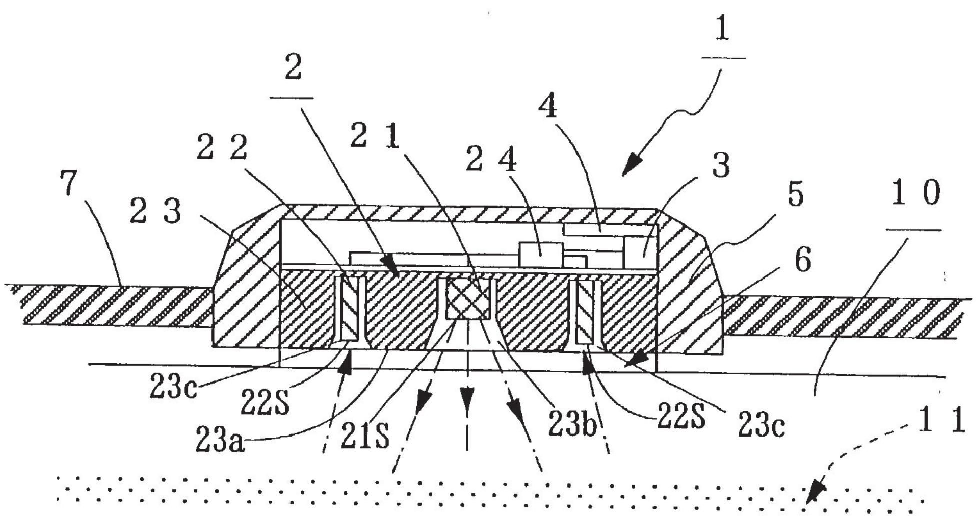
22

FIG. 1 (b)



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22S
23c
11

FIG. 2

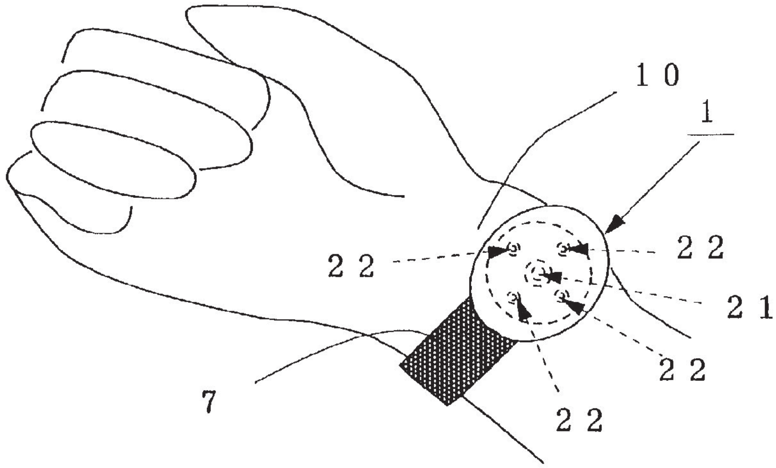


FIG. 3

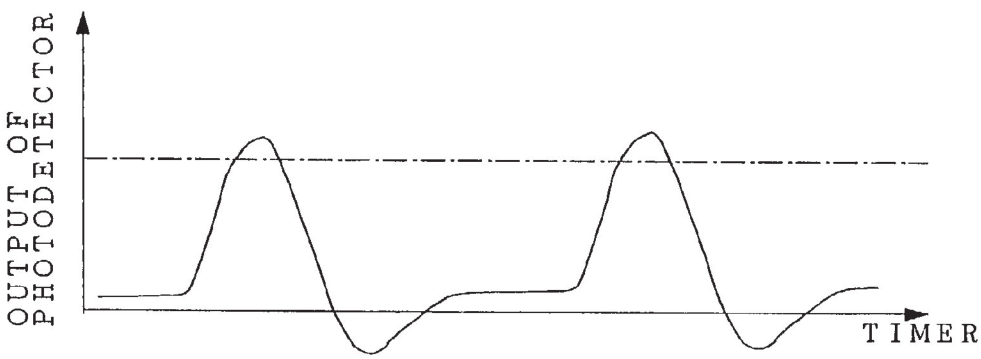


FIG. 4 (a)

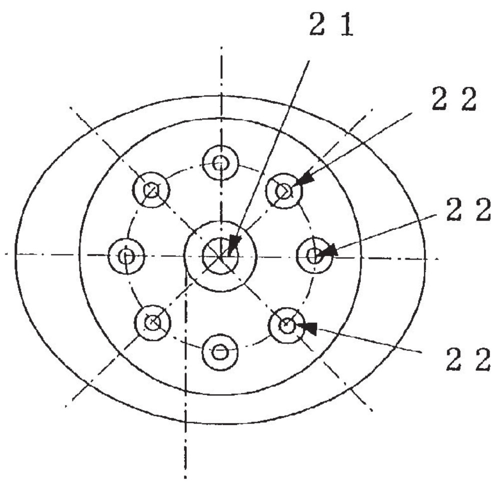


FIG. 4 (b)

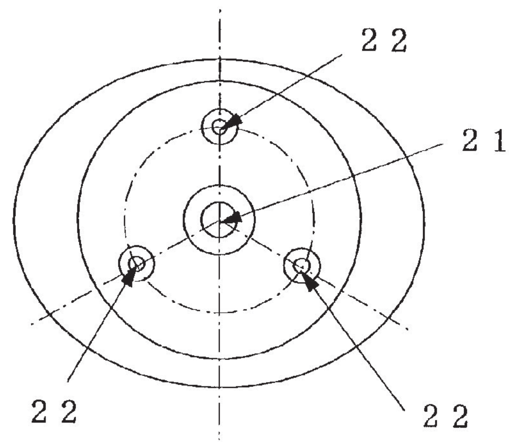
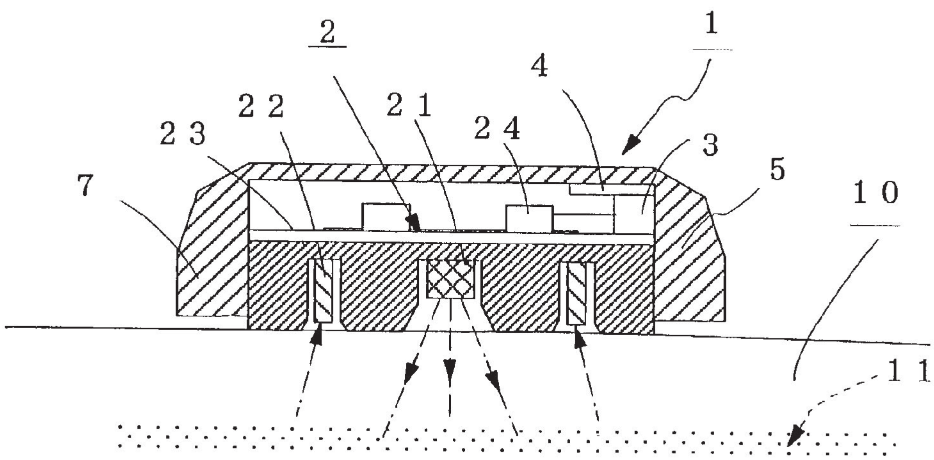


FIG. 5



PULSE WAVE SENSOR AND PULSE RATE DETECTOR

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a pulse wave sensor for detecting the pulse wave of a subject from light reflected from a red corpuscle in the artery of a wrist of the subject by irradiating the artery of the wrist with light having a wavelength of an infrared range and to a pulse rate detector for detecting the pulse rate of the subject from the above pulse wave data.

[0003] 2. Description of the Prior Art

[0004] In recent years, along with shift to the aging society and westernized eating habits, an increase in the number of diseases caused by life habits, such as hyperpiesia, diabetes mellitus, heart diseases and cerebrovascular diseases of the brain is becoming a big social problem. As means of preventing these diseases or treating the diseases, a personal exercise cure such as walking is widely adopted. In this exercise cure, a pedometer or kinetic calorimeter is carried to know the quantity of motion. There has recently been proposed a method of estimating a burden on the heart of a person who takes exercise by real-time measuring his/her heart rate at the time of exercise.

[0005] For the measurement of the above heart rate, an optical pulse wave sensor for detecting the pulse wave of a subject from reflected light or transmitted light by irradiating the site of a blood vessel with light having an infrared or near infrared range is widely used. Stated more specifically, a pulse wave sensor which comprises a pair of an LED (light emitting diode) and a phototransistor (photodetector) is attached to a finger or ear to measure the heart rate by calculating the cycle (frequency) of pulse waves from the waveform of reflected light or transmitted light detected by the above photodetector.

[0006] However, although the conventional pulse wave sensor to be attached to the finger or ear is small in size, a signal from the sensor is weak because it detects the motion of a red corpuscle in the capillary and is easily affected by noise caused by the shaking of the body of the subject. Also, as some pressure is applied to the measurement site at the time of detection, the subject cannot carry the detector for a long time when walking or the like.

[0007] Meanwhile, since a strong signal is obtained when the motion of a red corpuscle in the artery is detected, a detector to be attached to a wrist or arm is conceivable. As understood when the pulse of the wrist is actually taken, it is difficult to attach the sensor to a predetermined position. When the attachment position is dislocated, no output can be obtained, thereby making it difficult to implement the detector.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention which has been made in view of the above problem to provide a pulse wave sensor which is easily attached and is capable of detecting a pulse wave accurately and a pulse rate detector comprising this pulse wave sensor.

[0009] According to a first aspect of the present invention, there is provided a pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject, the sensor comprising at least three photodetectors disposed around the light emitting diode and not linearly. Even when the attachment position of the sensor is dislocated, a pulse wave can be detected accurately.

[0010] According to a second aspect of the present invention, there is provided a pulse sensor, wherein a near infrared LED which is a general-purpose product is used as the light emitting diode. This makes it possible to produce an inexpensive sensor.

[0011] According to a third aspect of the present invention, there is provided a pulse sensor, wherein the photodetectors are disposed at an equal distance from the light emitting diode.

[0012] According to a fourth aspect of the present invention, there is provided a pulse sensor, wherein cavities are formed in a contact face between a holder for holding the light emitting diode and the photodetectors and the wrist, the light emitting face of the light emitting diode and the light receiving faces of the photodetectors are disposed at respective predetermined distances from the contact face, and the sectional forms of the cavities are tapered such that their widths increase toward the contact face. Since this makes it possible to expand the light emitting area and the light receiving area, a pulse wave can be easily detected even when the attachment position of the sensor is dislocated.

[0013] According to a fifth aspect of the present invention, there is provided a pulse sensor, wherein a transparent plate-like member is provided on a portion including at least the light emitting face and the light receiving faces of the contact face. This makes it possible to improve adhesion between the sensor and the wrist and thereby further improve the detection efficiency of pulse waves.

[0014] According to a sixth aspect of the present invention, there is provided a pulse rate detector comprising the pulse wave sensor of claim 1 and means of computing the pulse rate of a subject based on the output of the pulse wave sensor.

[0015] According to a seventh aspect of the present invention, there is provided a pulse rate detector which comprises a transmitter for transmitting the measured pulse rate data to a display for displaying the pulse rate data and a device for computing the amount of motion load from the pulse rate.

[0016] The above and other objects, advantages and features of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIGS. **1** are schematic diagrams of a pulse rate detector according to an embodiment of the present invention;

[0018] **FIG. 2** is a diagram showing that the pulse rate detector is attached.

[0019] **FIG. 3** is a schematic diagram of a pulse wave which is the output of a photodetector;

[0020] FIGS. 4 are diagrams showing other arrangements of a light emitting diode and photodetectors according to the present invention; and

[0021] **FIG. 5** is a diagram showing a pulse rate detector according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Preferred embodiments of the present invention will be described hereinbelow with reference to the accompanying drawings.

[0023] FIGS. **1**(*a*) and **1**(*b*) are schematic diagrams of a pulse rate detector according to an embodiment of the present invention. **FIG. 1**(*a*) is a plan view and **FIG. 1**(*b*) is a sectional view of the pulse rate detector when it is attached. In these figures, reference numeral **2** denotes a pulse wave sensor which comprises an LED **21** (to be referred to as "light emitting diode" hereinafter) for emitting light having a wavelength of a near infrared range, four phototransistors **22** (to be referred to as "photodetectors" hereinafter) disposed around the light emitting diode **21** symmetrically on a circle concentric to the light emitting diode **21**, a holder **23** for storing the above light emitting diode **21** and the photodetectors **22**, and a drive detection circuit **24** for detecting a pulse wave by amplifying the outputs of the photodetectors **22**, **3** is an arithmetic circuit for computing a pulse rate from the detected pulse wave data, **4** a transmitter for transmitting the above pulse rate data to an unshown display, **5** an outer casing for storing the above pulse wave sensor **2**, the arithmetic circuit **3** and the transmitter **4**, **6** an acrylic transparent plate mounted to the detection face **23***a* of the holder **23** to be described hereinafter, and **7** an attachment belt attached to the above outer casing.

[0024] The above light emitting diode **21** and the above photodetectors **22** are stored in cavities **23***b* and **23***c* formed in the detection face **23***a* which is a contact side between the holder **23** and a wrist **10**, respectively, at positions where the light emitting face **21***s* of the light emitting diode **21** and the light receiving faces **22***s* of the photodetectors **22** are set back from the above detection face **23***a*. In this embodiment, to expand the light emitting area of the light emitting diode **21** and the light receiving areas of the photodetectors **22**, the sectional forms of the above cavities **23***b* and **23***c* are tapered such that their widths increase toward the contact face.

[0025] A description is subsequently given of the method of measuring a pulse rate.

[0026] As shown in **FIG. 2, a** subject carries the above pulse rate detector **1** on the inner side of his/her wrist **10** with a belt in such a manner that the light emitting face **21***s* of the light emitting diode **21** faces down (on the wrist **10** side). As shown in **FIG. 1**(*b*), the above belt **7** is fastened such that the acrylic transparent plate **6** becomes close to the artery **11** of the wrist **10**. Thereby, adhesion between the wrist **10** and the pulse rate detector **1** is improved. When the pulse rate detector **1** is attached to the wrist **10** with the belt **7**, pulse wave data can be detected at the same pressure as that for attaching a wrist watch with a belt. Therefore, the wrist **10** is not pressed hard, thereby making it possible to carry it for a long time.

[0027] Near infrared radiation output toward the wrist **10** from the light emitting diode **21** is reflected by a red corpuscle running through the artery **11** of the wrist **10** and this reflected light is detected by the plurality of photodetectors **22** so as to detect a pulse wave (see **FIG. 1**(*b*)). Since four photodetectors **22** are disposed around the light emitting diode **21** on a circle concentric to the light emitting diode **21** in this embodiment, even when the attachment position of the pulse rate detector **1** is dislocated, one of the photodetectors **22** is located near the artery **11**, thereby making it possible to detect a pulse wave accurately. If the plurality of photodetectors **22** are disposed linearly, all of the photodetectors **22** may be far from the artery **11**. Therefore, it is desired that the photodetectors **22** should not be disposed linearly.

[0028] **FIG. 3** schematically shows the waveform of a pulse wave which is the output of the above photodetector **22**. The detected pulse wave data is amplified by the drive detection circuit **24** and the amplified pulse wave data is transmitted to the arithmetic circuit **3**. The arithmetic circuit **3** has a threshold value and computes the number of outputs above the threshold value per unit time so as to calculate a pulse rate and the transmitter**4** transmits the pulse rate to a display for displaying the above pulse rate data and a device for computing the amount of motion load. Since the output of the above photodetector **22** is generally low, after the output is amplified, the amplified output is converted into a digital signal for the computation of a pulse rate in this embodiment.

[0029] According to this embodiment, the pulse wave of the wrist **10** of the subject is detected by the pulse wave sensor **2** which comprises the light emitting diode **21** for emitting light having a wavelength of a near infrared range and four photodetectors **22** disposed around the light emitting diode **21** symmetrically on a circle concentric to the light emitting diode **21**, and a pulse rate is computed from the pulse wave data by the arithmetic circuit **3**. Therefore, even when the attachment position of the pulse rate detector **1** is dislocated, a pulse wave can be detected accurately.

[0030] Since the acrylic transparent plate **6** is provided on the detection face **23***a* of the holder **23**, adhesion between the pulse rate detector **1** and the wrist **10** can be improved, thereby further improving the detection efficiency of a pulse wave.

[0031] In this embodiment, the pulse rate detector **1** is attached with the same pressure as that for attaching a timepiece to the wrist with a belt. Therefore, the subject can carry the pulse rate detector **1** for a long time without pressing his/her wrist excessively.

[0032] In the above embodiment, four photodetectors which are disposed symmetrically are used to detect the pulse wave of the wrist **10**. The arrangement of the light emitting diode **21** and the photodetectors **22** is not limited to this. For example, to further improve detection efficiency, as shown in **FIG. 4**(*a*), the number of the photodetectors **22** may be increased. Alternatively, to reduce the size of the pulse rate detector **1**, as shown in **FIG. 4**(*b*), the number of photodetectors may be reduced. In either case, it is desired that the photodetectors **22** should be disposed around the light emitting diode **21** on a circle concentric to the light emitting diode **21** to detect a pulse wave accurately even when the attachment position of the pulse rate detector **1** is dislocated.

[0033] In the above embodiment, a plurality of photodetectors **22** are provided for one light emitting diode **21**. The

same effect can be obtained when the number of photodetectors **22** is **1** and a plurality of light emitting diodes **21** are disposed around the photodetector **22**. In this case, the size and power consumption of the pulse wave sensor **2** become larger than this embodiment.

[**0034**] In the above embodiment, the acrylic transparent plate **6** is provided on the detection face **23***a* of the holder **23** to improve adhesion to the wrist **10**. Even when the detection face **23***a* is projected from the outer casing **5** as shown in **FIG. 5**, adhesion can be improved.

[**0035**] In the above embodiment, the pulse rate data is transmitted to the display or the device for computing the amount of motion load. When not only a pulse rate but also pulse wave data (waveform itself) are transmitted, the pulse rate detector **1** of the present invention can be coupled to devices making use of bio signals.

[**0036**] As described above, according to the present invention, since a pulse wave sensor is constituted such that light output from a light emitting diode and reflected from the artery of the wrist of a subject is detected by at least three photodetectors disposed around the light emitting diode and not linearly to detect a pulse wave, even when the attachment position of the sensor is dislocated, the pulse wave can be detected accurately. Using this sensor, a pulse rate detector which is easily attached and has a stable output can be constructed.

What is claimed is:

1. A pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject, the sensor comprising at least three photodetectors disposed around the light emitting diode.

2. The pulse wave sensor of claim 1, wherein a near infrared LED is used as the light emitting diode.

3. The pulse wave sensor of claim 1, wherein the photodetectors are disposed at an equal distance from the light emitting diode.

4. The pulse sensor of claim 1, wherein cavities are formed in a contact face between a holder for holding the light emitting diode and the photodetectors and the wrist, the light emitting face of the light emitting diode and the light receiving faces of the photodetectors are disposed at respective predetermined distances from the contact face, and the sectional forms of the cavities are tapered such that their widths increase toward the contact face.

5. The pulse wave sensor of claim 1, wherein a transparent plate-like member is provided on a portion including at least the light emitting face and the light receiving faces of the contact face.

6. A pulse rate detector comprising the pulse wave sensor of claim 1 and means of computing the pulse rate of a subject based on the output of the pulse wave sensor.

7. The pulse rate detector of claim 6 which comprises a transmitter for transmitting the measured pulse rate data.

* * * * *

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(54) **WRISTWATCH-TYPE HUMAN PULSE WAVE SENSOR ATTACHED ON BACK SIDE OF USER'S WRIST**

(76) Inventors: **Rie Ohsaki**, Anjo-city (JP); **Teiyuu Kimura**, Nagoya-city (JP); **Naoki Fukaya**, Obu-city (JP)

Correspondence Address:
LAW OFFICE OF DAVID G POSZ
2000 L STREET, N.W.
SUITE 200
WASHINGTON, DC 20036 (US)

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(52) **U.S. Cl.** **600/503**; 600/500

(57) **ABSTRACT**

A pulse wave sensor includes a detecting element and a sensor body. The pulse wave sensor is worn on the back side of a user's wrist corresponding to the back of the user's hand. The detecting element includes a translucent member on its top, and the translucent member has a convex surface. The detecting element is attached on the back side of the user's wrist by a dedicated belt so that the convex surface of the translucent member is in intimate contact with the surface of the user's skin. The sensor body is attached on the back side of the user's wrist by another dedicated belt so that it is arranged on the detecting element. A cushion is arranged between the sensor body and the detecting element. The pulse wave sensor can stably detect the pulse wave without being affected by the movement of the user's wrist.

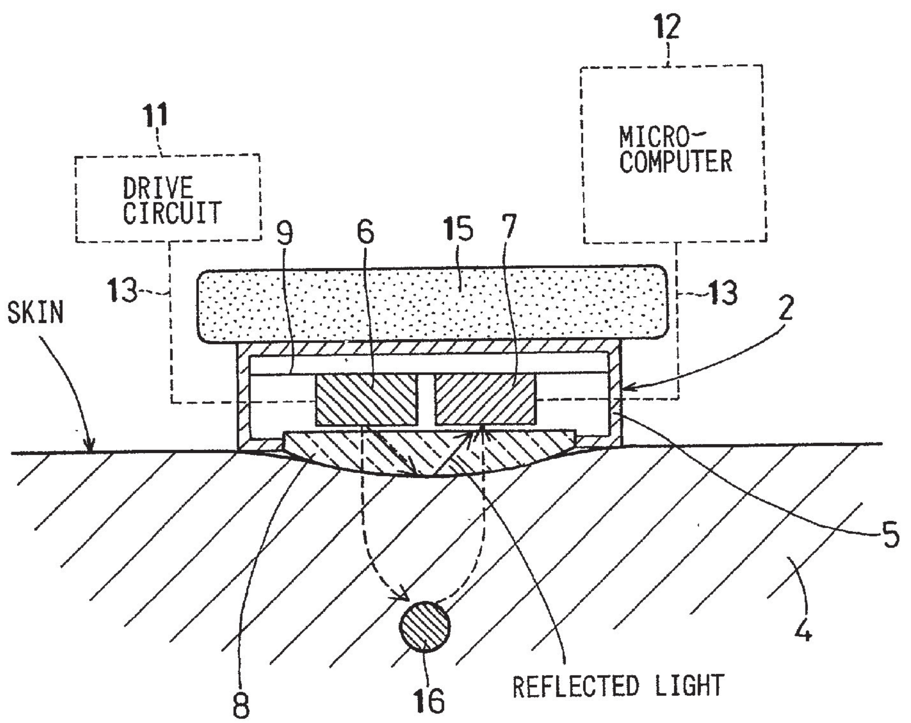


FIG. 1

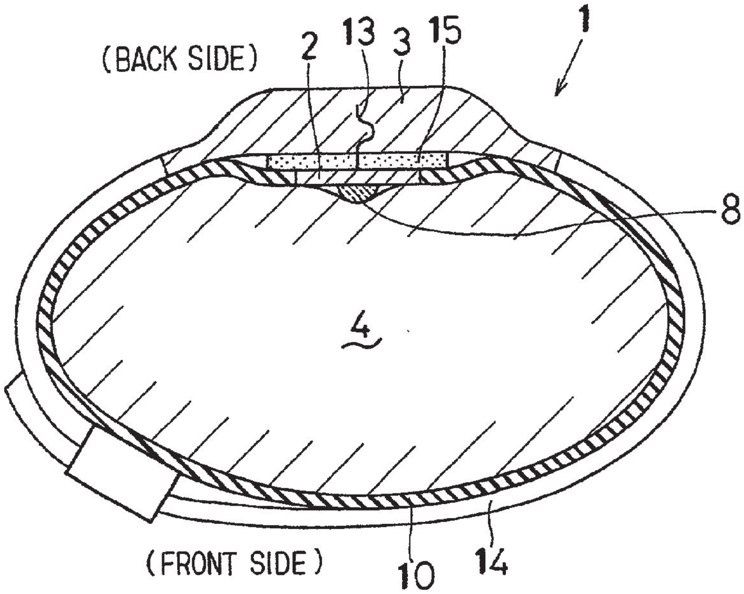

(BACK SIDE)
2
13
3
15
1
8
4
(FRONT SIDE)
10
14

FIG. 2

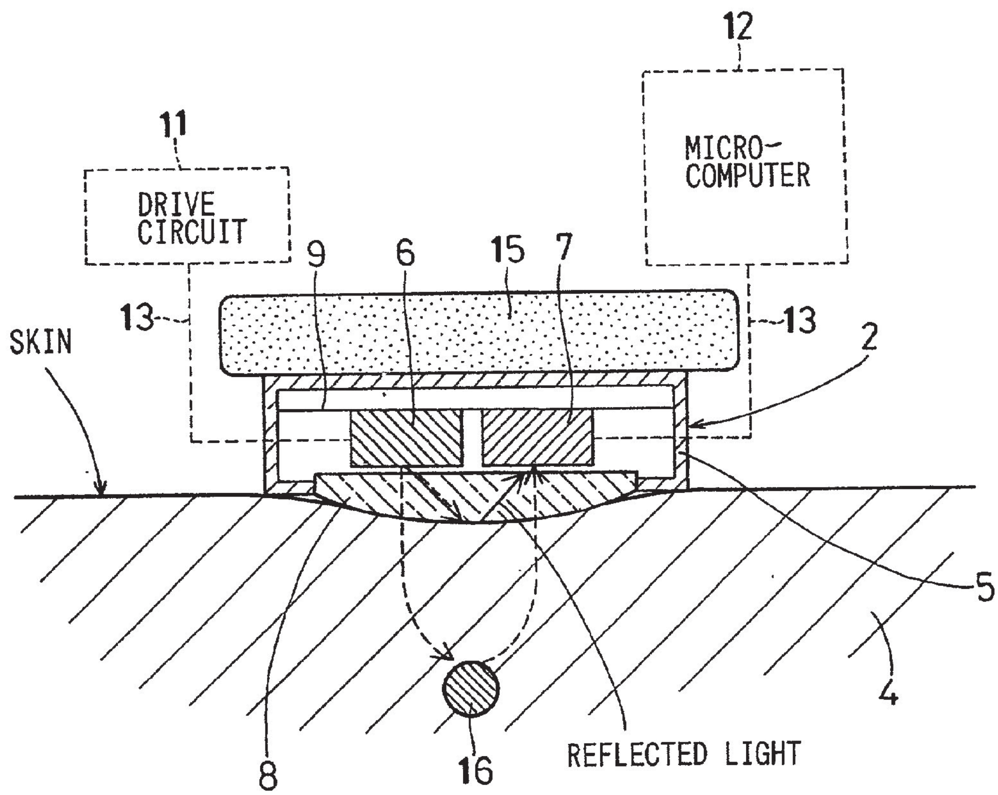

12
MICRO-COMPUTER
11
DRIVE CIRCUIT
9
6
15
7
13
13
2
SKIN
5
4
8
16
REFLECTED LIGHT

FIG. 3A

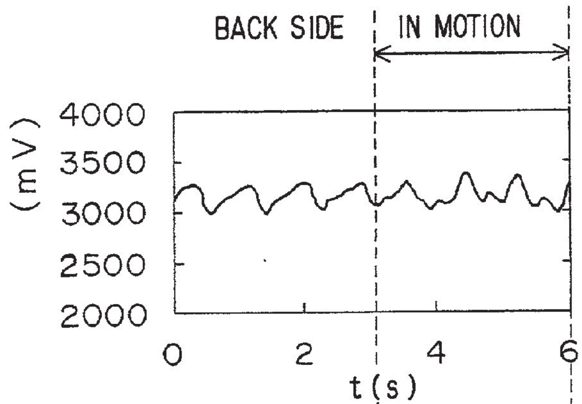


FIG. 3B

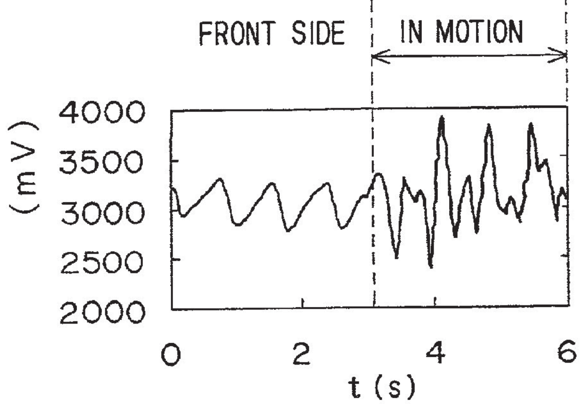


FIG. 4A

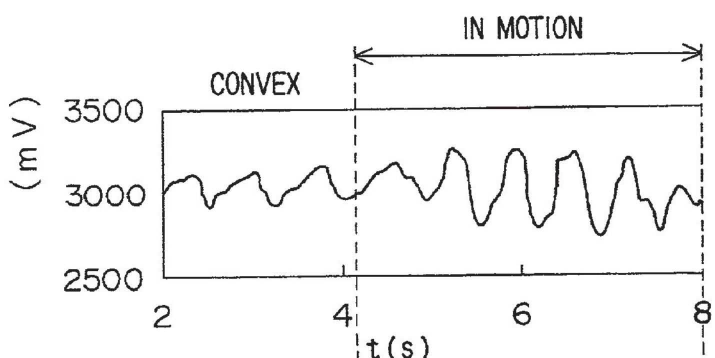
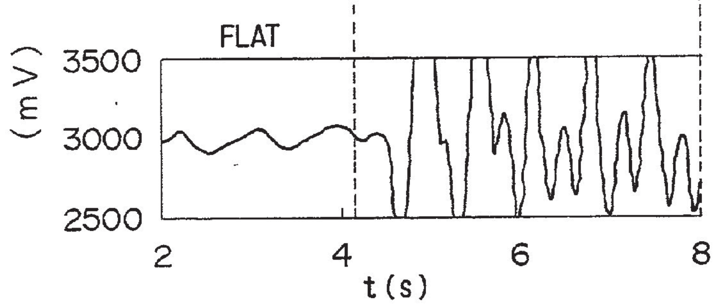


FIG. 4B



WRISTWATCH-TYPE HUMAN PULSE WAVE SENSOR ATTACHED ON BACK SIDE OF USER'S WRIST

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on and incorporates herein by reference Japanese Patent Application No.2000-177999 filed on Jun. 14, 2000.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an optical sensor for detecting the pulse wave of a human body.

[0004] 2. Related Art

[0005] JP-A-11-70087 proposes a wristwatch-type device for detecting the pulse wave of a human body. This detecting device is worn on the user's wrist. The device includes a detecting element for detecting a pulse wave and a sensor body including a display. The detecting element is fixed on the front side of the user's wrist corresponding to the palm of the user's hand by a band attached to the sensor body. The information of pulse wave detected by the detecting element is displayed on the display of the sensor body fixed on the back side of the user's wrist.

[0006] The two bones (the radius and the ulna) pass through the front side of the user's wrist. Therefore the detecting element has a tendency to slip off the detection position of the user's wrist, since the skin surface of the front side of the user's wrist greatly moves as the user's wrist moves. Furthermore, the user feels uncomfortable since the radius and the ulna are pressed. As a result, the user further moves his/her wrist unconsciously and it becomes further difficult to detect the pulse wave stably.

SUMMARY OF THE INVENTION

[0007] The present invention overcomes the above drawbacks, and has an object to provide a human pulse wave sensor which is capable of detecting the pulse wave of a human body stably and has high detection probability.

[0008] The pulse wave sensor according to the present invention includes a detecting element and a sensor body. The pulse wave sensor is worn on the back side of the user's wrist corresponding to the back of the user's hand for detecting the pulse wave of the user. The detecting element includes a light emitting element and a light receiving element. The sensor body is connected to the detecting element by a signal line.

[0009] Preferably, a translucent member is arranged on the light emitting element and the light receiving element. The translucent member has a convex surface. The detecting element is attached on the back side of the user's wrist by a dedicated belt so that the convex surface of the translucent member is in intimate contact with the surface of the user's skin. The light emitting element and the light receiving element are arranged in the longitudinal direction of the user's arm. The sensor body is attached on the back side of the user's wrist by a dedicated belt other than the belt of the detecting element so that it is arranged on the detecting element. A cushion is arranged between the sensor body and the detecting element.

[0010] According to this construction, the user does not feel uncomfortable when the pulse wave sensor is worn on the user's wrist. Furthermore the detecting element is fixed on the user's wrist without slipping off the detection position of the user's wrist, even if the user is in motion. Accordingly the pulse wave sensor can stably detect the pulse wave of the user.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

[0012] **FIG. 1** is a cross-sectional view of a pulse wave sensor attached on the user's wrist;

[0013] **FIG. 2** is a schematic diagram of a mechanism for detecting a pulse wave;

[0014] **FIGS. 3A and 3B** are graphs of the pulse wave detected by a pulse wave sensor attached on the back side of the user's wrist and the pulse wave detected by a pulse wave sensor attached on the front side of the user's wrist, respectively; and

[0015] **FIGS. 4A and 4B** are graphs of the pulse wave detected by a pulse wave sensor including a convex detecting surface and the pulse wave detected by a pulse wave sensor including a flat detecting surface, respectively.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Referring to **FIG. 1, a** pulse wave sensor **1** includes a detecting element **2** and a sensor body **3**. The pulse wave sensor **1** is worn on the back side of the user's wrist **4** corresponding to the back of the user's hand in the similar manner as a wristwatch is normally worn. This sensor **1** is used for detecting the pulse wave of the user's body for a medical diagnosis, a physical check up, and the like.

[0017] Referring to **FIG. 2**, the detecting element **2** comprises a package **5**, a light emitting element **6** (e.g., LED), a light receiving element **7** (e.g., PD), and a translucent board **8**. The package **5** has an opening and includes a circuit board **9** therein. The light emitting element **6** and light receiving element **7** are included in the package **5** and arranged on the circuit board **9**. The translucent board **8** is a glass board which is transparent to light, and attached to the opening of the package **5**. A convex surface is formed on the top of the translucent board **8** as shown in **FIG. 2**.

[0018] The detecting element **2** is fixed on the user's wrist **4** by a dedicated belt **10** attached to the detecting element **2** as shown in **FIG. 1**. The belt **10** may be made from elastic material so that regular pressure is applied to the user's wrist **4**. In this case, it is prevented that light reflected by the surface of the skin or disturbance light from the outside penetrates the translucent board **8**, since the surface of the translucent board **8** is in intimate contact with the surface of the user's skin. However the user feels uncomfortable if the pressure applied to the user's wrist **4** is too high. Therefore it is desirable that the pressure applied to the user's wrist **4** is limited to 5-15 mmHg.

[0019] The light emitting element 6 and the light receiving element 7 are arranged side by side as shown in FIG. 2. Accordingly the length of the detecting element 2 from the right side to the left side in FIG. 2 is longer than the length from the upper side to the lower side. If the detecting element 2 is arranged so that its longitudinal direction (from the right side to the left side in FIG. 2) agrees with the circumferential direction of the user's wrist 4, it has a tendency to slip off. Therefore it is desirable that the detecting element 2 is arranged so that its longitudinal direction agrees with the longitudinal direction of the user's arm. The dedicated belt 10 is attached to the detecting element 2 so that it can fix the detecting element 2 on the user's wrist 4 in this way.

[0020] The sensor body 3 is connected to the detecting element 2 by a signal line 13, and includes, as shown in FIG. 2, a drive circuit 11, a microcomputer 12, and a monitor display (not shown). The drive circuit 11 drives the light emitting element 6 to emit light toward the wrist 4. The microcomputer 12 calculates the pulse rate from the reflected light received by the detecting element 2. This reflected light varies with the user's pulsation. The monitor display shows the calculated pulse rate and the like.

[0021] The sensor body 3 is arranged on the top of the detecting element 2, and fixed on the user's wrist 4 by a dedicated belt 14 attached to the sensor body 3. A cushion 15 such as a sponge or a gel is inserted between the detecting element 2 and the sensor body 3 so that the detecting element 2 does not directly contact the sensor body 3.

[0022] The pulse wave sensor 1 detects the pulse wave of the user's body as follows. The light emitting element 6 emits light toward the user's wrist 4, a portion of the emitted light penetrates the capillary arteriole 16 in the inside of the user's wrist 4 and is absorbed by the haemoglobin in the blood. The rest of the emitted light is reflected and scattered by the capillary arteriole 16, and partly reaches the light emitting element 7. As the amount of the haemoglobin in the blood varies in waves due to the pulsation of the user's blood, the amount of the light absorbed by the haemoglobin also varies in waves. As a result, the amount of the light which is reflected by the capillary arteriole 16 and reaches the light receiving element 7 varies in waves. This variation in the amount of the light received by the light receiving element 7 is detected as the pulse wave information.

[0023] If the detecting element 2 is arranged on the front side of the user's wrist 4, the amount of the light received the light receiving element 7 is larger. That is, the intensity of the signal received by the light receiving element 7 is higher. However, the detecting element 2 has a tendency to slip off the detecting position of the user's wrist 4 as the user moves his/her wrist, and therefore the intensity of the light received by the light receiving element 7 largely varies depending on the shift amount of the detecting element 2. As shown in FIG. 3B, in the case that the detecting element 2 is arranged on the front side of the user's wrist 4, the pulse wave can be detected well if the user is at rest. However, when the user is in motion, the detected pulse wave is adversely affected by the movement of the user's wrist 4.

[0024] In contrast to this, if the detecting element 2 is arranged on the back side of the user's wrist 4, the user will not move his/her wrist unconsciously since the radius and the ulna inside the user's wrist 4 are not pressed and consequently the user does not feel so uncomfortable. Further, the detecting element 2 will not shift so widely even if the user's wrist moves. Therefore the detecting element 2 is stably fixed to the detecting position of the user's wrist 4. As a result, the pulse wave is detected stably without being affected by the movement of the user's wrist 4 as shown in FIG. 3A.

[0025] The detecting element 2 is arranged on the user's wrist 4 so that the convex surface of the translucent board 8 is in intimate contact with the surface of the user's skin. Thereby it is prevented that the detecting element 2 slips off the detecting position of the user's wrist 4. If the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist 4 as shown in FIG. 4B. However, in the case that the translucent board 8 has a convex surface like the present embodiment, the variation of the amount of the reflected light which is emitted from the light emitting element 6 and reaches the light receiving element 7 by being reflected by the surface of the user's skin is suppressed. It is also prevented that noise such as disturbance light from the outside penetrates the translucent board 8. Therefore the pulse wave can be detected without being affected by the movement of the user's wrist 4 as shown in FIG. 4A.

[0026] The detecting element 2 and the sensor body 3 is attached to theuser's wrist 4 by the dedicated belts10 and 14, respectively. That is, the detecting element 2 and the sensor body 3 are allowed to move relatively. Further the cushion 15 is arranged between the detecting element 2 and the sensor body 3. Therefore, if force is applied to the sensor body 3 or the sensor body 3 moves, the force applied to the sensor body 3 or the movement of the sensor body 3 cannot be transmitted to the detecting element 2 easily.

[0027] Accordingly the detecting element 2 is stably fixed to the user's wrist 4. As a result, the pulse wave sensor can detect the pulse wave at a high S/N ratio, that is, it can provide high detection probability, not only when the user is at rest but also when the user is taking light exercise.

[0028] Modifications

[0029] In the above embodiment, the sensor body 3 need not include the microcomputer 12 if it includes a transmitter instead. In this case, the pulse wave information detected by the detecting element 2 is transmitted to a receiver by the transmitter. The sensor body 3 can be downsized and light in weight in this case and consequently the force applied to the sensor body 3 or the movement of the sensor body 3 cannot be transmitted to the detecting element 2 easily.

[0030] In the above embodiment, the detecting element 2 and the sensor body 3 may be worn on the back side of the user's forearm.

What is claimed is:

1. A pulse wave sensor for detecting a pulse wave of a human body comprising:

a detecting element including a light emitting element and a light receiving element; and

a sensor body including a circuit connected to the detecting element via a signal line,

wherein the detecting element is constructed to be worn on a back side of a user's wrist or a user's forearm.

2. A pulse wave sensor as set forth in claim 1, wherein:

the detecting element includes a translucent member which is transparent to light and arranged on the light emitting element and the light receiving element;

the translucent member has a convex surface; and

the translucent member is arranged on the back side of the user's wrist or the user's forearm so that the convex surface of the translucent member is in intimate contact with a surface of the user's skin.

3. A pulse wave sensor for detecting a pulse wave of a human body comprising:

a detecting element including a light emitting element and a light receiving element; and

a sensor body including a circuit connected to the detecting element via a signal line,

wherein the detecting element is constructed to be worn on a user's wrist or a user's forearm,

the pulse wave sensor further comprising:

a first belt for fixing the detecting element to the user's wrist or the user's forearm; and

a second belt for fixing the sensor body to the user's wrist or the user's forearm.

4. A pulse wave sensor for detecting a pulse wave of a human body comprising:

a detecting element including a light emitting element and a light receiving element; and

a sensor body including a circuit connected to the detecting element via a signal line,

wherein the detecting element is constructed to be worn on a user's wrist or a user's forearm,

wherein the sensor body is arranged on the detecting element, and

wherein a cushion is arranged between the detecting element and the sensor body.

5. A pulse wave sensor for detecting a pulse wave of a human body comprising:

a detecting element including a light emitting element and a light receiving element; and

a sensor body including a circuit connected to the detecting element via a signal line,

wherein the detecting element is constructed to be worn on a user's wrist or a user's forearm,

wherein the light emitting element and the light receiving element are arranged side by side in a longitudinal direction of the user's arm.

6. A pulse wave sensor as set forth in claim 5, wherein:

the detecting element includes a translucent member which is transparent to light and arranged on the light emitting element and the light receiving element;

the translucent member has a convex surface; and

the translucent member is arranged on the user's wrist or the user's forearm so that the convex surface of the translucent member is in intimate contact with a surface of the user's skin.

7. A pulse wave sensor as set forth in claim 6 further comprising:

a first belt for fixing the detecting element to the user 's wrist or the user's forearm; and

a second belt for fixing the sensor body to the user's wrist or the user's forearm.

8. A pulse wave sensor as set forth in claim 7, wherein:

the sensor body is arranged on the detecting element; and

a cushion is arranged between the detecting element and the sensor body.

* * * * *

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New York City, USA, Aug 30-Sept 3, 2006

A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring

Y. Mendelson*, *Member, IEEE,* R. J. Duckworth, *Member, IEEE,* and G. Comtois, *Student Member, IEEE*

Abstract—**To save life, casualty care requires that trauma injuries are accurately and expeditiously assessed in the field. This paper describes the initial bench testing of a wireless wearable pulse oximeter developed based on a small forehead mounted sensor. The battery operated device employs a lightweight optical reflectance sensor and incorporates an annular photodetector to reduce power consumption. The system also has short range wireless communication capabilities to transfer arterial oxygen saturation (SpO_2), heart rate (HR), body acceleration, and posture information to a PDA. It has the potential for use in combat casualty care, such as for remote triage, and by first responders, such as firefighters.**

I. Introduction

STEADY advances in noninvasive physiological sensing, hardware miniaturization, and wireless communication are leading to the development of new wearable technologies that have broad and important implications for civilian and military applications [1]-[2]. For example, the emerging development of compact, low-power, small-size, light- weight, and unobtrusive wearable devices may facilitate remote noninvasive monitoring of vital signs from soldiers during training exercises and combat. Telemetry of physiological information via a short-range wirelessly-linked personal area network can also be useful for firefighters, hazardous material workers, mountain climbers, or emergency first-responders operating in harsh and hazardous environments. The primary goals of such a wireless mobile platform would be to keep track of an injured person's vital signs, thus readily allowing the telemetry of physiological information to medical providers, and support emergency responders in making critical and often life saving decisions in order to expedite rescue operations. Having wearable physiological monitoring could offer far-forward medics numerous advantages, including the ability to determine a casualty's condition remotely without exposing the first responders to increased risks, quickly identifying the severity of injuries especially when the injured are greatly dispersed over large geographical terrains and often out-of-site, and continuously tracking the injured condition until they arrive safely at a medical care facility.

Several technical challenges must be overcome to address the unmet demand for long-term continuous physiological monitoring in the field. In order to design more compact sensors and improved wearable instrumentation, perhaps the most critical challenges are to develop more power efficient and low-weight devices. To become effective, these technologies must also be robust, comfortable to wear, and cost-effective. Additionally, before wearable devices can be used effectively in the field, they must become unobtrusive and should not hinder a person's mobility. Employing commercial off-the-shelf (COTS) solutions, for example finger pulse oximeters to monitor blood oxygenation and heart rate, or standard adhesive-type disposable electrodes for ECG monitoring, is not practical for many field applications because they limit mobility and can interfere with normal tasks.

A potentially attractive approach to aid emergency medical teams in remote triage operations is the use of a wearable pulse oximeter to wirelessly transmit heart rate (HR) and arterial oxygen saturation (SpO_2) to a remote location. Pulse oximetry is a widely accepted method that is used for noninvasive monitoring of SpO_2 and HR. The method is based on spectrophotometric measurements of changes in the optical absorption of deoxyhemoglobin (Hb) and oxyhemoglobin (HbO_2). Noninvasive spectrophotometric measurements of SpO_2 are performed in the visible (600-700nm) and near-infrared (700-1000nm) spectral regions. Pulse oximetry also relies on the detection of photoplethysmographic (PPG) signals produced by variations in the quantity of arterial blood that is associated with periodic contractions and relaxations of the heart. Measurements can be performed in either transmission or reflection modes. In transmission pulse oximetry, the sensor can be attached across a fingertip, foot, or earlobe. In this configuration, the light emitting diodes (LEDs) and photodetector (PD) in the sensor are placed on opposite sides of a peripheral pulsating vascular bed. Alternatively, in reflection pulse oximetry, the LEDs and PD are both mounted side-by-side on the same planar substrate to enable readings from multiple body locations where trans-illumination measurements are not feasible. Clinically, forehead reflection pulse oximetry has been used as an alternative approach to conventional transmission-based

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*Corresponding author – Y. Mendelson is a Professor in the Department of Biomedical Engineering, Worcester Polytechnic Institute, Worcester, MA 01609 USA (phone: 508-831-5103; fax: 508-831-5541; e-mail: ym@wpi.edu).

R. J. Duckworth is a Professor in the Department of Electrical and Computer Engineering, Worcester Polytechnic Institute, Worcester, MA 01609 USA (rjduck@ece.wpi.edu).

G. Comtois is a M. S. student in the Department of Biomedical Engineering, Worcester Polytechnic Institute, Worcester, MA 01609 USA (comtoisg@wpi.edu).

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oximetry when peripheral circulation to the extremities is compromised.

Pulse oximetry was initially intended for in-hospital use on patients undergoing or recovering from surgery. During the past few years, several companies have developed smaller pulse oximeters, some including data transmission via telemetry, to further expand the applications of pulse oximetry. For example, battery-operated pulse oximeters are now attached to patients during emergency transport as they are being moved from a remote location to a hospital, or between hospital wards. Some companies are also offering smaller units with improved electronic filtering of noisy PPG signals.

Several reports described the development of a wireless pulse oximeter that may be suitable for remote physiological monitoring [3]-[4]. Despite the steady progress in miniaturization of pulse oximeters over the years, to date, the most significant limitation is battery longevity and lack of telemetric communication. In this paper, we describe a prototype forehead-based reflectance pulse oximeter suitable for remote triage applications.

II. System Architecture

The prototype system, depicted in Fig. 1, consists of a body-worn pulse oximeter that receives and processes the PPG signals measured by a small (ϕ = 22mm) and lightweight (4.5g) optical reflectance transducer. The system

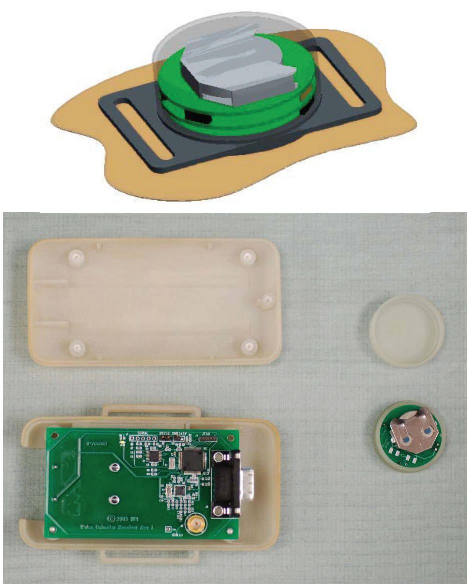

Fig. 1. (Top) Attachment of Sensor Module to the skin; (Bottom) photograph of the Receiver Module (left) and Sensor Module (right).

consists of three units: A Sensor Module, consisting of the optical transducer, a stack of round PCBs, and a coin-cell battery. The information acquired by the Sensor Module is transmitted wirelessly via an RF link over a short range to a body-worn Receiver Module. The data processed by the Receiver Module can be transmitted wirelessly to a PDA. The PDA can monitor multiple wearable pulse oximeters simultaneously and allows medics to collect vital physiological information to enhance their ability to extend more effective care to those with the most urgent needs. The system can be programmed to alert on alarm conditions, such as sudden trauma, or physiological values out of their normal range. It also has the potential for use in combat casualty care, such as for remote triage, and for use by first responders, such as firefighters.

Key features of this system are small-size, robustness, and low-power consumption, which are essential attributes of wearable physiological devices, especially for military applications. The system block diagram (Fig. 2), is described in more detail below.

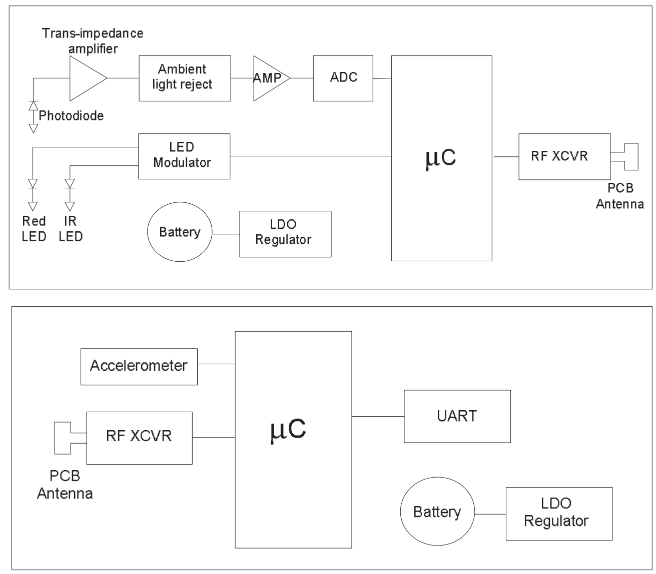

Fig. 2. System block diagram of the wearable, wireless, pulse oximeter. Sensor Module (top), Receiver Module (bottom).

Sensor Module: The Sensor Module contains analog signal processing circuitry, ADC, an embedded microcontroller, and a RF transceiver. The unit is small enough so the entire module can be integrated into a headband or a helmet. The unit is powered by a CR2032 type coin cell battery with 220mAh capacity, providing at least 5 days of operation.

Receiver Module: The Receiver Module contains an embedded microcontroller, RF transceiver for communicating with the Sensor Module, and a Universal Asynchronous Receive Transmit (UART) for connection to a PC. Signals acquired by the Sensor Module are received by the embedded microcontroller which synchronously converts the corresponding PD output to R and IR PPG signals. Dedicated software is used to filter the signals and compute SpO_2 and HR based on the relative amplitude and frequency content of the reflected PPG signals. A tri-axis MEMS accelerometer detects changes in body activity, and the information obtained through the tilt sensing property of the accelerometer is used to determine the orientation of the person wearing the device.

To facilitate bi-directional wireless communications between the Receiver Module and a PDA, we used the DPAC Airborne™ LAN node module (DPAC Technologies, Garden Grove, CA). The DPAC module operates at a frequency of 2.4GHz, is 802.11b wireless compliant, and has a relatively small (1.6 × 1.17 × 0.46 inches) footprint. The wireless module runs off a 3.7VDC and includes a built-in

TCP/IP stack, a radio, a base-band processor, an application processor, and software for a "drop-in" WiFi application. It has the advantage of being a plug-and-play device that does not require any programming and can connect with other devices through a standard UART.

PDA: The PDA was selected based on size, weight, and power consumption. Furthermore, the ability to carry the user interface with the medic also allows for greater flexibility during deployment. We chose the HP iPAQ h4150 PDA because it can support both 802.11b and Bluetooth™ wireless communication. It contains a modest amount of storage and has sufficient computational resources for the intended application. The use of a PDA as a local terminal also provides a low-cost touch screen interface. The user-friendly touch screen of the PDA offers additional flexibility. It enables multiple controls to occupy the same physical space and the controls appear only when needed. Additionally, a touch screen reduces development cost and time, because no external hardware is required. The data from the wireless-enabled PDA can also be downloaded or streamed to a remote base station via Bluetooth or other wireless communication protocols. The PDA can also serve to temporarily store vital medical information received from the wearable unit.

A dedicated National Instruments LabVIEW program was developed to control all interactions between the PDA and the wearable unit via a graphical user interface (GUI). One part of the LabVIEW software is used to control the flow of information through the 802.11b radio system on the PDA. A number of LabVIEW VIs programs are used to establish a connection, exchange data, and close the connection between the wearable pulse oximeter and the PDA. The LabVIEW program interacts with the Windows CE™ drivers of the PDA's wireless system. The PDA has special drivers provided by the manufacturer that are used by Windows CE™ to interface with the 802.11b radio hardware. The LabVIEW program interacts with Windows CE™ on a higher level and allows Windows CE™ to handle the drivers and the direct control of the radio hardware.

The user interacts with the wearable system using a simple GUI, as depicted in Fig. 3.

Fig. 3. Sample PDA Graphical User Interface (GUI).

The GUI was configured to present the input and output information to the user and allows easy activation of various functions. In cases of multiple wearable devices, it also allows the user to select which individual to monitor prior to initiating the wireless connection. Once a specific wearable unit is selected, the user connects to the remote device via the System Control panel that manages the connection and sensor control buttons. The GUI also displays the subject's vital signs, activity level, body orientation, and a scrollable PPG waveform that is transmitted by the wearable device.

The stream of data received from the wearable unit is distributed to various locations on the PDA's graphical display. The most prominent portion of the GUI display is the scrolling PPG waveform, shown in Fig. 3. Numerical SpO_2 and HR values are displayed is separate indicator windows. A separate tri-color indicator is used to annotate the subject's activity level measured by the wearable accelerometer. This activity level was color coded using green, yellow, or red to indicate low or no activity, moderate activity, or high activity, respectively. In addition, the subject's orientation is represented by a blue indicator that changes orientation according to body posture. Alarm limits could be set to give off a warning sign if the physiological information exceeds preset safety limits.

One of the unique features of this PDA-based wireless system architecture is the flexibility to operate in a free roaming mode. In this ad-hoc configuration, the system's integrity depends only on the distance between each node. This allows the PDA to communicate with a remote unit that is beyond the PDA's wireless range. The ad-hoc network would therefore allow medical personnel to quickly distribute sensors to multiple causalities and begin immediate triage, thereby substantially simplifying and reducing deployment time.

Power Management: Several features were incorporated into the design in order to minimize the power consumption of the wearable system. The most stringent consideration was the total operating power required by the Sensor Module, which has to drive the R and IR LEDs, process the data, and transmit this information wirelessly to the Receive Module. To keep the overall size of the Sensor Module as small as, it was designed to run on a watch style coin-cell battery.

It should be noted that low power management without compromising signal quality is an essential requirement in optimizing the design of wearable pulse oximeter. Commercially available transducers used with transmission and reflection pulse oximeters employ high brightness LEDs and a small PD element, typically with an active area ranging between 12 to $15mm^2$. One approach to lowering the power consumption of a wireless pulse oximeter, which is dominated by the current required to drive the LEDs, is to reduce the LED duty cycle. Alternatively, minimizing the drive currents supplied to the R and IR LEDs can also achieve a significant reduction in power consumption. However, with reduced current drive, there can be a direct impact on the quality of the detected PPGs. Furthermore, since most of the light emitted from the LEDs is diffused by the skin and subcutaneous tissues, in a predominantly forward-scattering direction, only a small fraction of the incident light is normally backscattered from the skin. In

addition, the backscattered light intensity is distributed over a region that is concentric with respect to the LEDs. Consequently, the performance of reflectance pulse oximetry using a small PD area is significantly degraded. To overcome this limitation, we showed that a concentric array of either discrete PDs, or an annularly-shaped PD ring, could be used to increase the amount of backscattered light detected by a reflectance type pulse oximeter sensor [5]-[7].

Besides a low-power consuming sensor, afforded by lowering the driving currents of the LEDs, a low duty cycle was employed to achieve a balance between low power consumption and adequate performance. In the event that continuous monitoring is not required, more power can be conserved by placing the device in an ultra low-power standby mode. In this mode, the radio is normally turned off and is only enabled for a periodic beacon to maintain network association. Moreover, a decision to activate the wearable pulse oximeter can be made automatically in the event of a patient alarm, or based on the activity level and posture information derived from the on-board accelerometer. The wireless pulse oximeter can also be activated or deactivated remotely by a medic as needed, thereby further minimizing power consumption.

III. In Vivo Evaluations

Initial laboratory evaluations of the wearable pulse oximeter included simultaneous HR and SpO_2 measurements. The Sensor Module was positioned on the forehead using an elastic headband. Baseline recordings were made while the subject was resting comfortably and breathing at a normal tidal rate. Two intermittent recordings were also acquired while the subject held his breath for about 30 seconds. Fig. 4 displays about 4 minutes of SpO_2 and HR recordings acquired simultaneously by the sensor.

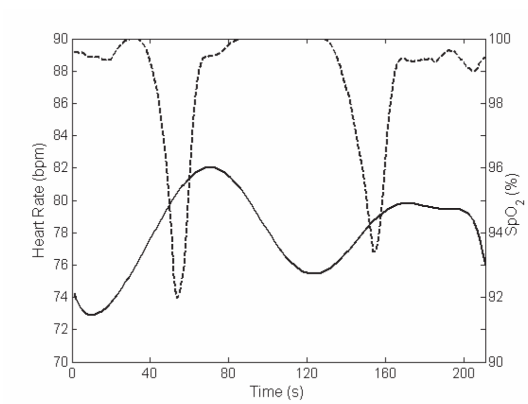

Fig. 4. Typical HR (solid line) and SpO_2 (dashed line) recording of two voluntary hypoxic episodes.

The pronounced drops in SpO_2 and corresponding increases in HR values coincide with the hypoxic events associated with the two breath holding episodes.

IV. Discussion

The emerging development of compact, low power, small size, light weight, and unobtrusive wearable devices can facilitate remote noninvasive monitoring of vital physiological signs. Wireless physiological information can be useful to monitor soldiers during training exercises and combat missions, and help emergency first-responders operating in harsh and hazardous environments. Similarly, wearable physiological devices could become critical in helping to save lives following a civilian mass casualty. The primary goal of such a wireless mobile platform would be to keep track of an injured person's vital signs via a short-range wirelessly-linked personal area network, thus readily allowing RF telemetry of vital physiological information to command units and remote off-site base stations for continuous real-time monitoring by medical experts.

The preliminary bench testing plotted in Fig. 4 showed that the SpO_2 and HR readings are within an acceptable clinical range. Similarly, the transient changes measured during the two breath holding maneuvers confirmed that the response time of the custom pulse oximeter is adequate for detecting hypoxic episodes.

V. Conclusion

A wireless, wearable, reflectance pulse oximeter has been developed based on a small forehead-mounted sensor. The battery-operated device employs a lightweight optical reflectance sensor and incorporates an annular photodetector to reduce power consumption. The system has short range wireless communication capabilities to transfer SpO_2, HR, body acceleration, and posture information to a PDA carried by medics or first responders. The information could enhance the ability of first responders to extend more effective medical care, thereby saving the lives of critically injured persons.

Acknowledgment

The authors would like to acknowledge the financial support provided by the U.S. Army Medical Research and Material Command referenced.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Jeroen Poeze et al.	
U.S. Patent No.:	10,624,564	Attorney Docket No.: 50095-0023IP1
Issue Date:	April 21, 2020	
Appl. Serial No.:	16/725,292	
Filing Date:	Dec. 23, 2019	
Title:	MULTI-STREAM DATA COLLECTION SYSTEM FOR NONINVASIVE MEASUREMENT OF BLOOD CONSTITUENTS	

SECOND DECLARATION OF DR. THOMAS W. KENNY

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code.

Dated: October 27, 2021 By: ________________________

Thomas W. Kenny, Ph.D.

Decision. APPLE-1003, [0021]-[0022]; Institution Decision, 11-12.

4. I have no financial interest in the party or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

5. In writing this declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of mechanical engineering, computer science, biomedical engineering, and electrical engineer; my experience in teaching those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed various publications and materials, in addition to other materials I cite in my declaration.

6. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the '564 Patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the fields as of the Critical Date, or before.

II. Ground 1

7. As I explained at length in my first declaration, a POSITA "would have found it obvious to modify the [Aizawa] sensor's flat cover…to include a lens/protrusion…similar to Ohsaki's translucent board 8, so as to [1] improve adhesion between the user's wrist and the sensor's surface, [2] improve detection efficiency, [3] and protect the elements within the sensor housing." APPLE-1003,

¶¶66-73. Rather than attempting to rebut my testimony on these points, Masimo and its witness, Dr. Madisetti, responded with arguments that are technically and factually flawed.

8. Specifically, Masimo contends that "Ohsaki and Aizawa employ different sensor structures (rectangular versus circular) for different measurement locations (back side versus palm side of the wrist), using different sensor surface shapes (convex versus flat) that are tailored to those specific measurement locations" and from this concludes that "[a] POSITA would [not] have been motivated to combine the references and reasonably expected such a combination to be successful." IPR2020-01713, Pap. 14 ("**POR**"), 1-3.

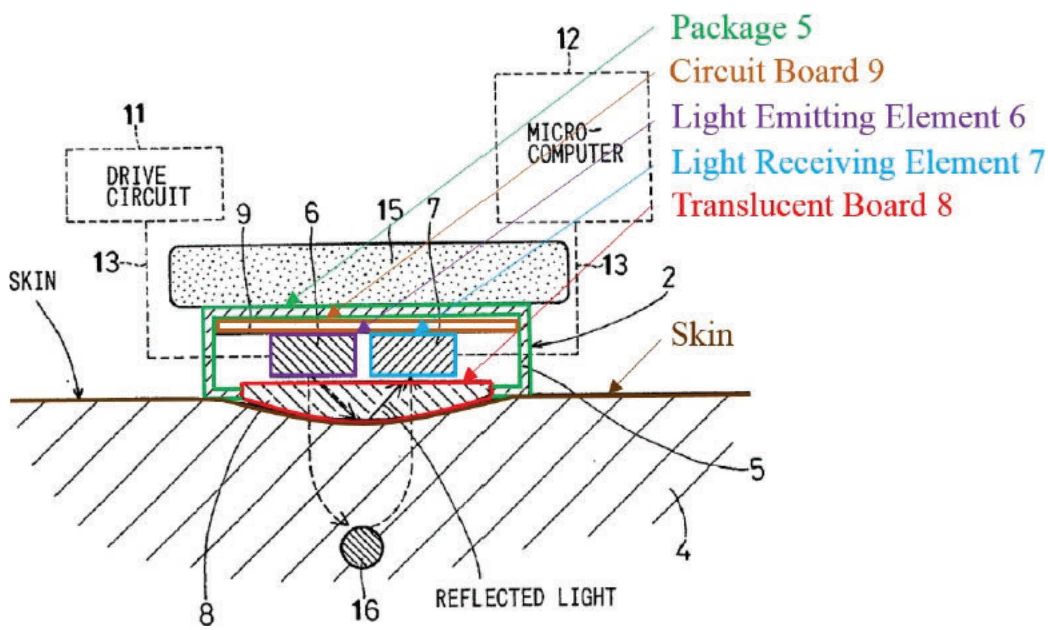
9. In this way and as I explain in further detail, the POR avoids addressing the merits of the combinations advanced in Apple's Petition, relies on mischaracterizing the prior art combinations and my testimony, and ignores the inferences and creative steps that a POSITA would have taken when modifying Aizawa's sensor to achieve the benefits taught by Ohsaki and Goldsmith.

10. Contrary to Masimo's contentions, Ohsaki does not limit its benefits to a rectangular sensor applied to a particular body location, and a POSITA would not have understood those benefits as being so limited. For example, Ohsaki teaches that "the detecting element and the sensor body 3 may be worn on the back side of the user's forearm" or wrist. Nowhere does Ohsaki teach that its sensor can only be worn on a particular body location. APPLE-1009, [0030], [0008]-[0010], Abstract.

In its summary of invention and claim preambles, Ohsaki explains that the object of its invention is "to provide a human pulse wave sensor which is capable of detecting the pulse wave ***of a human body*** stably and has high detection probability." APPLE-1009, [0007], claims 1-8. Thus, Ohsaki's disclosure should not be narrowly understood as applying to a single location or a single embodiment. Aizawa similarly reveals an embodiment in which its sensor is located on the palm side of the wrist (*see* APPLE-1006, FIG. 2, 0002, 0009), but does not limit its sensor to being applied to just the palm side of the wrist. A POSITA, based on Aizawa and Ohsaki's disclosure, would have understood that the sensors in Aizawa and Ohsaki, when combined in the manner explained in my earlier declaration, would have been applicable to various locations on a human body and would have improved the performance of the sensor by providing the benefits described in these disclosures. Indeed, a POSITA would understand that the claimed benefits of the detector arrangement and the convex cover would have been useful and beneficial for measurements on many other locations.

11. In addition to the above, as shown in Ohsaki's FIG. 2 (reproduced below), Ohsaki attributes the reduction of slippage afforded by use of translucent board 8 (and additional related improvements in signal quality) to the fact that "***the convex surface of the translucent board…is in intimate contact with the surface of the user's skin***"[1] when the sensor is worn. APPLE-1003, ¶¶54, 68; APPLE-1009, [0015], [0017], [0025], FIGS. 1, 2, 4A, 4B.

APPLE-1009, FIG. 2 (annotated).



12. Notably absent from Ohsaki's discussion of these benefits is any mention or suggestion that they relate to the shape of the perimeter of translucent board 8 (whether circular, rectangular, ovoid, or other). Rather, when describing the

[1] Unless otherwise noted, emphases in quotations throughout my declaration are added.

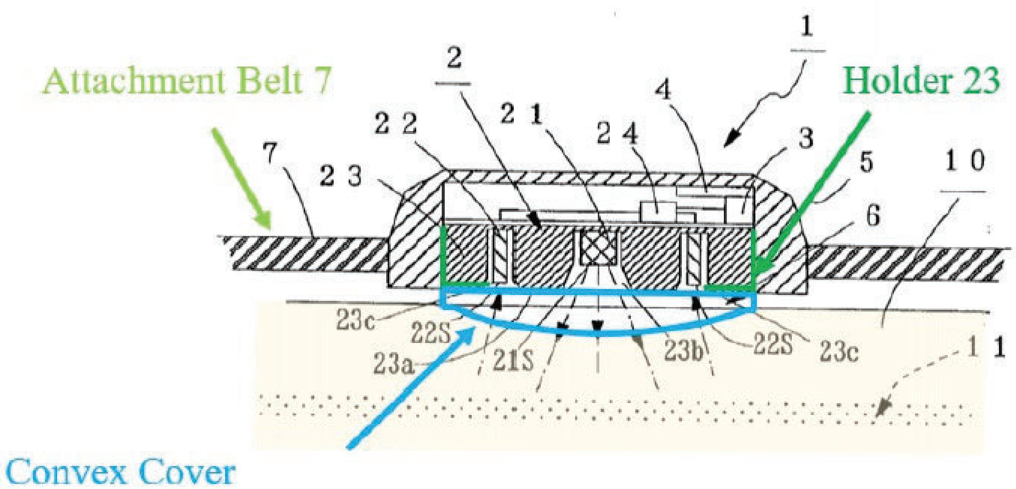
advantages associated with translucent board 8, Ohsaki contrasts a "convex detecting surface" from a "flat detecting surface," and explains that "if the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist," but that ***if the board "has a convex surface…variation of the amount of the reflected light…that reaches the light receiving element 7 is suppressed***." APPLE-1003, ¶69; APPLE-1009, [0015], [0025].

13. From this and related description, a POSITA would have understood that a protruding convex cover would reduce the adverse effects of user movement on signals obtainable by photodetectors which are positioned to detect light reflected from user tissue. APPLE-1003, ¶¶107, 131, 48; APPLE-1009, [0015], [0017], [0025], FIGS. 1, 2, 4A, 4B; *see also* APPLE-1006, [0012], [0013], [0023], [0024], [0026], [0030], [0034], FIGS. 1(a), 1(b). A POSITA would expect that these benefits would apply to the pulse wave sensor of Aizawa, as well as to other wearable physiological monitors.

14. In addition, as I explain with respect to the prior art figures reproduced below, the POSITA would have found it obvious to improve Aizawa's sensor based on Ohsaki's teachings, and would have been fully capable of making any inferences and creative steps necessary to achieve the benefits obtainable by modifying Aizawa's cover to feature a convex detecting surface.[2] *See also* APPLE-1008, ¶¶14-15, FIG. 1;

[2] Nowhere in Ohsaki is the cover depicted or described as rectangular. APPLE-

APPLE-1015, [0012], [0024], [0033], [0035], FIG. 6. The following annotated FIG. 1(b) from Aizawa shows the results of the proposed combination:



APPLE-1006, FIG. 1(b)(annotated)

15. And, contrary to Masimo's contentions, the POSITA would have in no way been dissuaded from achieving those benefits by a specific body location associated with Ohsaki's sensor. POR, 25-38. Indeed, a POSITA would have understood that a light permeable convex cover would have provided improved adhesion as described by Ohsaki in a sensor placed, for example, on the palm side of the wrist or other locations on the body. APPLE-1009, [0025], Claim 3 (stating that "the detecting element is constructed to be worn on a user's wrist or a user's forearm" without specifying a back or front of the wrist or forearm), FIGS 4A, 4B; *see also* APPLE-1021, 91.

1047, ¶14; APPLE-1009, [0001]-[0030]; FIGS. 1, 2, 3A, 3B, 4A, 4B.

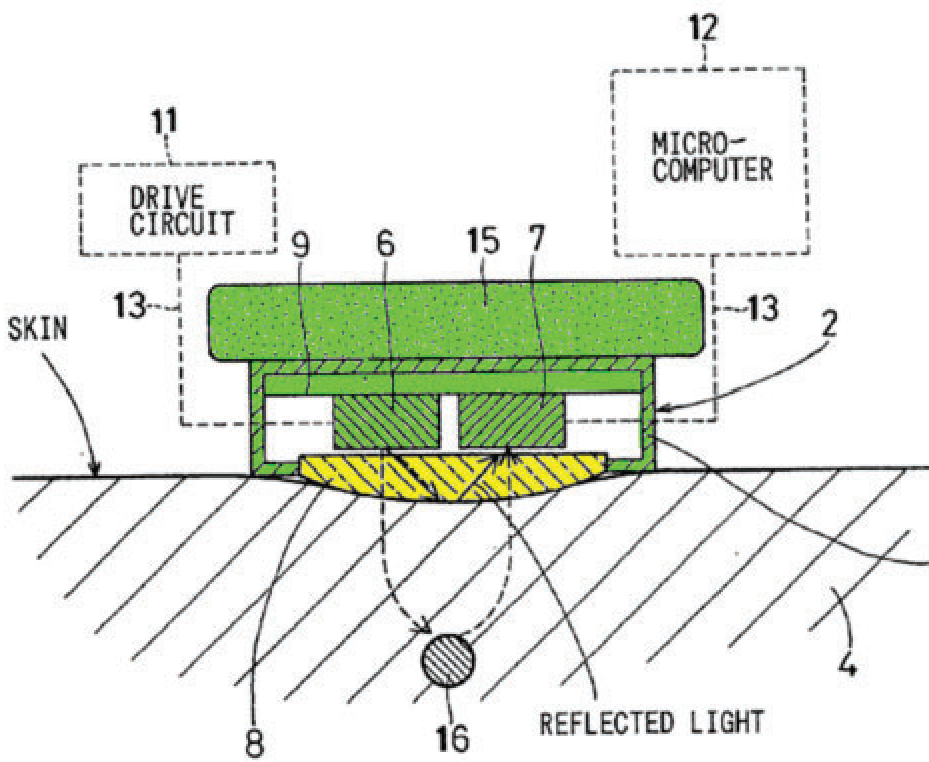
16. A POSITA would also have understood that certain locations present anatomical features that provide for easy measurement of large reflected light signals and others present anatomical features that reduce the amplitude of the reflected light signals. Because of this, a POSITA would be motivated to search for features from other references that can provide improved adhesion, improved light gathering, reduced leakage of light from external sources, and protection of the elements within the system in order to successfully detect a pulse wave signal from many locations.

17. For these and other reasons explained below, Masimo's arguments should be rejected. The sections below address the arguments with respect to Ground 1 presented in Masimo's POR and explain, in more detail, why those arguments fail.

A. Ohsaki does not teach or require that its translucent board 8 is "rectangular" in shape

18. In my first declaration, I explained that a POSITA would have modified Aizawa in view of Ohsaki such that Aizawa's cover "would include a convex surface, improving adhesion between a subject's wrist and a surface of the sensor." APPLE-1003, ¶67 (citing APPLE 1009, [0025] Ohsaki explains that the "convex surface of the translucent board 8" is responsible for this improved adhesion). Masimo argues that it is not the "convex surface" that improves adhesion in Ohsaki, but instead the "longitudinal shape" of "Ohsaki's translucent board [8]." *See* POR, 10, 17-25 (citing APPLE-1009, [0019]). However, the portion of Ohsaki cited does not include any reference to board 8. *See* APPLE-1009, [0019]. Ohsaki does ascribe a "longitudinal"

shape to a different component: "detecting element 2." *See id*. Ohsaki never describes the "translucent board 8" as "longitudinal," and nowhere describes "translucent board 8" and "detecting element 2" as having the same shape. *See generally* APPLE-1009. In fact, as illustrated in Ohsaki's FIG. 2 (reproduced below), translucent board 8 (annotated yellow) is not coextensive with the entire tissue-facing side of detecting element 2 (annotated green).

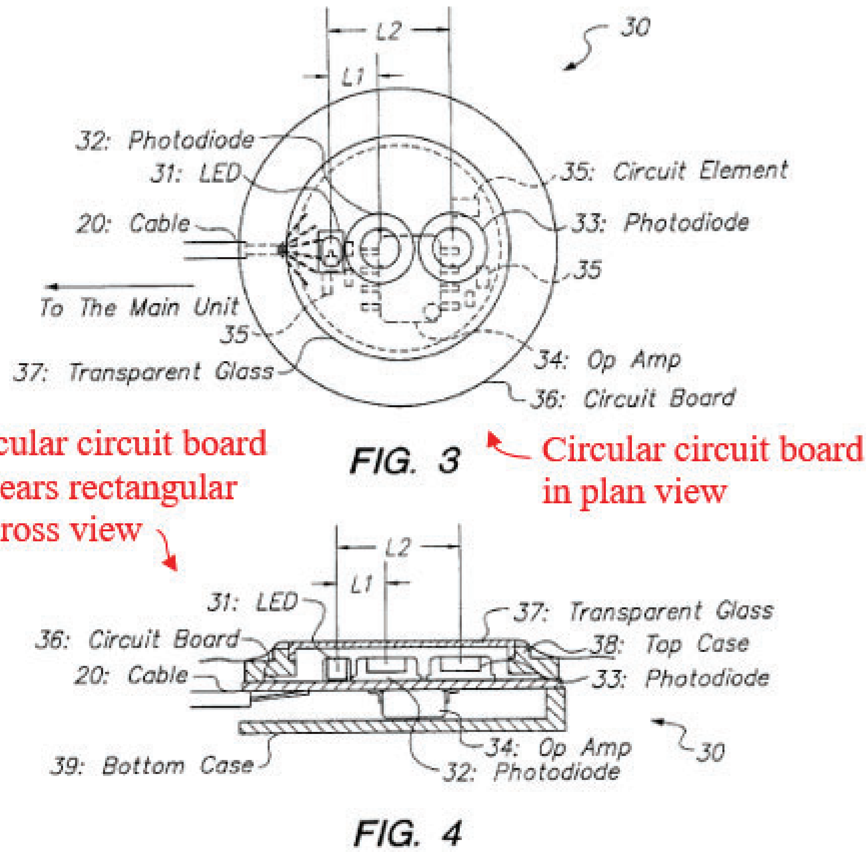


APPLE-1009, FIG. 2 (annotated)

19. Based on the unsupported contention that translucent board 8 has a "very pronounced longitudinal directionality," Masimo concludes that the translucent board 8 has a "rectangular" shape that is allegedly incompatible with Aizawa. *See* POR,

16-17. But Ohsaki never describes translucent board 8, or any other component, as "rectangular"; in fact, the words "rectangular" and "rectangle" do not appear in Ohsaki's disclosure. *See generally* APPLE-1009.

20. Indeed, the POR incorrectly assumes that because Ohsaki's light emitting element and the light receiving element are arranged in a longitudinal structure, Ohsaki's translucent board must have a rectangular structure. APPLE-1009, [0009], [0019]; POR, 1-3, 13-25. A POSITA would have known and understood that an elliptical or circular sensor or board configuration can also have a longitudinal structure or appearance under a cross-sectional view. An example illustrating such an understanding, ***contrary to POR's flawed assumption***, is shown below in US Patent No. 6,198,951 ("Kosuda")'s FIGS. 3 and 4. APPLE-1060, 8:42-56.



APPLE-1060, FIGS 3 and 4

21. Attempting to confirm its false conclusion, Masimo asserts that "***Ohsaki illustrates two cross-sectional views*** of its board that confirm it is rectangular." POR, 14 (citing Ex. 2004, [39]-[42]). Masimo identifies these "two cross-sectional views" as FIGS. 1 and 2, and infers the supposed "rectangular shape" of the translucent board 8 based on FIG. 1 showing the "short" side of the device, and FIG. 2 showing the "long" side of the same device. *See* POR, 14-16. But, according to Ohsaki, FIG. 2 is "a schematic diagram," not a cross-sectional view, and Ohsaki never specifies that FIGS. 1 and 2 are different views of the same device. APPLE-1009, [0013]. Accordingly, nothing in Ohsaki supports Masimo's inference that the "translucent

board 8" ***must be*** "rectangular" in shape. *See, e.g.,* APPLE-1009, [0013], [0019], [0025], FIG. 2; *Hockerson-Halberstadt, Inc. v. Avia Group Int'l*, 222 F.3d 951, 956 (Fed. Cir. 2000). Further, even if it is possible for the translucent board 8 to be "rectangular," Ohsaki certainly does not teach nor include any disclosure "***requiring***" this particular shape. *Id.*

22. Section B.1 of the POR presents multiple arguments with respect to Ground 1 that are premised on Ohsaki ***requiring*** the translucent board 8 to be "rectangular." *See* POR, 17-25. Because Ohsaki discloses no such shape for the translucent board 8, these arguments fail.

23. In addition, as discussed above, even if Ohsaki's translucent board 8 were somehow understood to be rectangular, a POSITA would have been fully capable of modifying Aizawa to feature a light permeable protruding convex cover to obtain the benefits attributed to such a cover by Ohsaki. For example, a POSITA would have found it obvious to include a circular light-permeable convex cover based on the teachings of Ohsaki, and take reasonable steps to make sure that the combination of a circular protruding convex cover would function with the other features present in Aizawa so as to provide the benefits discussed above.

B. A POSITA would have recognized the benefits of Ohsaki's teachings when applied to Aizawa's sensor

24. Masimo contends that "Ohsaki indicates that its sensor's convex board ***only*** improves adhesion when used on the ***back*** (i.e., watch) side of the wrist," and that

"Aizawa ***requires*** its sensor be positioned on the palm side of the wrist," and therefore reaches a conclusion that "[a] POSITA seeking to improve adhesion of Aizawa's sensor would not incorporate a feature that only improves adhesion at a different and unsuitable measurement location." POR, 25-26. But Ohsaki does not describe that its sensor can ***only*** be used at a backside of the wrist, and Aizawa never requires that its sensor be positioned on the palm side of the wrist. Instead, at most, these disclosures simply describe these arrangements with respect to a preferred embodiment. APPLE-1009, [0019].

25. Indeed, Ohsaki's specification and claim language reinforce that Ohsaki's description would not have been understood as limited to one side of the wrist. For example, Ohsaki explains that "the detecting element 2…may be worn on the back side of the user's forearm" as one form of modification. *See* APPLE-1009, [0030], [0028] (providing a section titled "[m]odifications"). The gap between the ulna and radius bones at the forearm is even greater than the gap between bones at the wrist, which is already wide enough to easily accommodate a range of sensor sizes and shapes, including circular shapes. In addition, Ohsaki's claim 1 states that "the detecting element is constructed to be worn on a back side of a user's wrist ***or a user's forearm***." *See also* APPLE-1009, claims 1-2. As another example, Ohsaki's independent claim 5 and dependent claim 6 state that "the detecting element is constructed to be worn on a user's wrist or a user's forearm," ***without even mentioning a backside*** of the wrist or forearm. *See also* APPLE-1009, Claims 6-8.

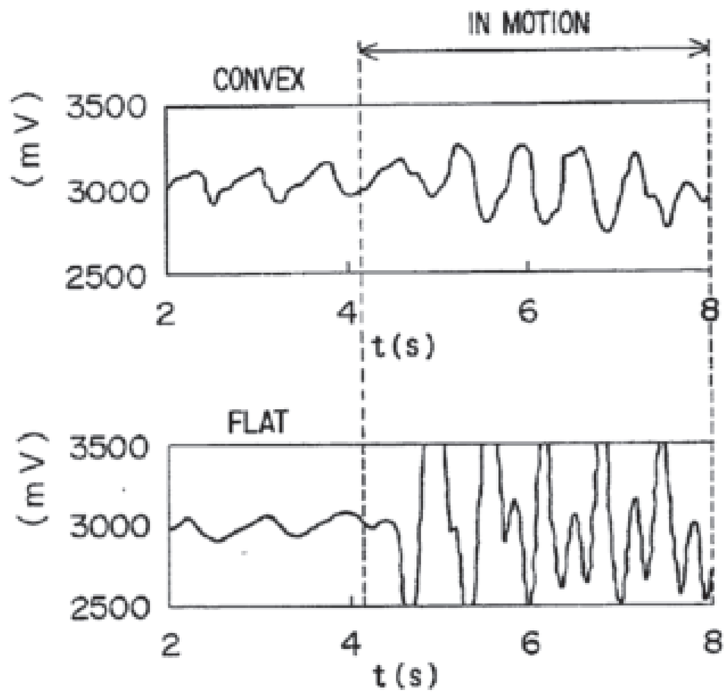
A POSITA would have understood this language to directly contradict Masimo's assertion that "[t]o obtain any benefit from Ohsaki's board, the sensor must be positioned on the backhand side of the wrist." POR, 16. A POSITA would have understood that Ohsaki's benefits provide improvements when the sensor is placed on either side of the user's wrist or forearm. APPLE-1009, [0025], FIGS. 4A, 4B.

26. Section B.2 of the POR presents several arguments with respect to Ground 1 that are premised on Ohsaki ***requiring*** the detecting element to be worn on a back side of a user's wrist or a user's forearm. *See* POR, 25-38. Because Ohsaki requires no such location for the translucent board 8, these arguments fail.

27. Moreover, even assuming, for the sake of argument, that a POSITA would have understood Aizawa's sensor as being limited to placement on the backside of the wrist, and would have understood Ohsaki's sensor's "tendency to slip" when arranged on the front side as informing consideration of Ohsaki's teachings with respect to Aizawa, that ***would have further motivated*** the POSITA to implement a light permeable convex cover in Aizawa's sensor, to improve detection efficiency of that sensor when placed on the palm side. APPLE-1009, [0015], [0017], [0023], [0025], FIGS. 1, 2, 3A, 3B, 4A, 4B.

28. When describing advantages associated with its translucent board, Ohsaki explains with reference to FIGS. 4A and 4B (reproduced below) that "if the translucent board 8 has a flat surface, the detected pulse wave is adversely affected by the movement of the user's wrist," but that if the board "has a convex

surface…variation of the amount of the reflected light…that reaches the light receiving element 7 is suppressed." APPLE-1003, ¶¶69-70; APPLE-1009, [0015], [0017], [0025].



APPLE-1009, FIGS. 4A, 4B

29. Contrary to Masimo's contentions, a POSITA would not have understood these benefits of a convex surface over a flat surface to be limited to one side or the other of the user's wrist, or to any particular location. APPLE-1009, [0023]-[0025]. Rather, a POSITA would have understood that, by promoting "intimate contact with the surface of the user's skin," a light permeable convex cover would have increased adhesion and reduced slippage of Aizawa's sensor when placed on either side of a user's wrist or forearm, and additionally would have provided associated improvements in signal quality. APPLE-1009, [0015], [0017], [0025]; FIGS. 1, 2, 4A, 4B, claims 3-8; *see also* APPLE-1021, 87, 91. Indeed, a POSITA would have

recognized that modifying Aizawa's flat plate to feature a convex protruding surface, as taught by Ohsaki, would have furthered Aizawa's stated goal of "improv[ing] adhesion between the sensor and the wrist" to "thereby further improve the detection efficiency." APPLE-1006, [0013], [0026], [0030], [0034].

30. Further, the POSITA would have been fully capable of employing inferences and creative steps when improving Aizawa based on Ohsaki's teachings, and would have expected success when applying those teachings. Indeed, a POSITA would have understood that adding a convex protrusion to Aizawa's flat plate would have provided an additional adhesive effect that would have reduced the tendency of that plate to slip.

C. Modifying Aizawa's sensor to include a convex cover as taught by Ohsaki enhances the sensor's light-gathering ability

31. Masimo argues that the combined sensor "would direct light away from the detectors and thus decrease light collection and optical signal strength." *See, e.g.,* POR, 38-39. As explained below, a POSITA would have understood the opposite to be true—that a cover featuring a convex protrusion would improve Aizawa's signal-to-noise ratio by causing more light backscattered from tissue to strike Aizawa's photodetectors than would have with a flat cover. APPLE- 1021, 52, 86, 90; APPLE-1051, 84, 87-92, 135-141; APPLE-1059, 803-805; APPLE-1006, FIGS. 1(a)-1(b). The convex cover enhances the light-gathering ability of Aizawa's sensor.

32. Masimo and its witness, Dr. Madisetti, assert that "a POSITA would have

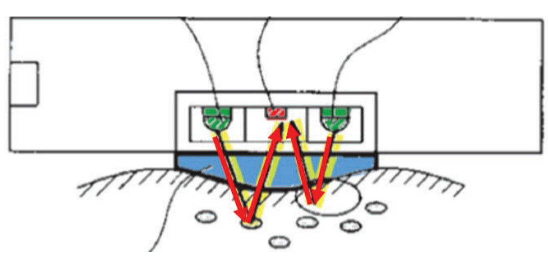
believed that a convex surface would…direct[] light away from the periphery and towards the center of the sensor." In so doing, POR and Dr. Madisetti fail to articulate a coherent position—e.g., whether Masimo's position is that "all" light or only "some" light is directed "to" or "towards the center." POR, 38-44, Ex. 2004, ¶¶79-88.

33. For example, Dr. Madisetti testified during deposition that "as I describe in my Declaration...if you have a convex surface...***all light*** reflected or otherwise would be condensed or directed towards the center." APPLE-1054, 40:4-11; *see also id.*, 127:22-128:18; Ex. 2004, 52 ("A POSITA Would Have Understood That a Convex Cover Directs Light ***To The Center*** Of The Sensor"), ¶¶80-83. However, during the same deposition, Dr. Madisetti further stated that that a convex cover would redirect light "towards the center," which could be "a general area at which the convex surface would be redirecting…light" or "a point," while contrasting the phrase "to the center" from "towards the center." APPLE-1054, 105:12-107:1, 133:19-135:11.

34. In contrast, and as explained in more detail below, I have consistently testified that a POSITA would have understood that a convex cover improves "light concentration at pretty much ***all of the locations under the curvature of the lens***," and for at least that reason would have been motivated to modify Aizawa's sensor to include a convex cover as taught by Ohsaki. POR, 39-43; Ex. 2006, 164:8-16.

i. Masimo ignores the well-known principle of reversibility

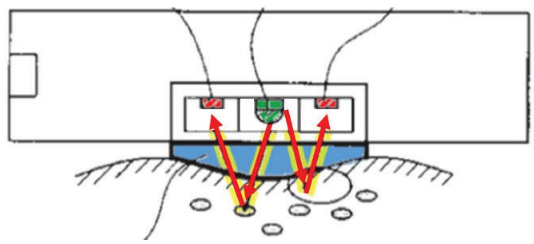
35. The well-known optical ***principle of reversibility*** dispels Masimo's claim that "a convex cover condenses light towards the center of the sensor and away from the periphery," when applied to Aizawa. POR, 39; APPLE-1051, 87-92; APPLE-1052, 106-111. According to the principle of reversibility, "a ray going from P to S will trace the same route as one from S to P." APPLE-1051, 92, 84; APPLE-1052, 101, 110; APPLE-1053, 80:20-82:20. Importantly, the principle dictates that rays that are not completely absorbed by user tissue will propagate in a reversible manner. In other words, every ray that completes a path through tissue from an LED to a detector would trace an identical path through that tissue in reverse, if the positions of the LED emitting the ray and the receiving detector were swapped. APPLE-1051, 92. To help explain, I have annotated Inokawa's FIG. 2 (presented below) to illustrate the principle of reversibility applied in the context of a reflective optical physiological monitor. As shown, Inokawa's FIG. 2, illustrates two example ray paths from surrounding LEDs (green) to a central detector (red):



APPLE-1007, FIG. 2 (annotated)

36. As a consequence of the principle of reversibility, a POSITA would have understood that if the LED/detector configuration were swapped, as in Aizawa, the

two example rays would travel identical paths in reverse, from a central LED (red) to surrounding detectors (green). A POSITA would have understood that, for these rays, any condensing/directing/focusing benefit achieved by Inokawa's cover (blue) under the original configuration would be identically achieved under the reversed configuration:



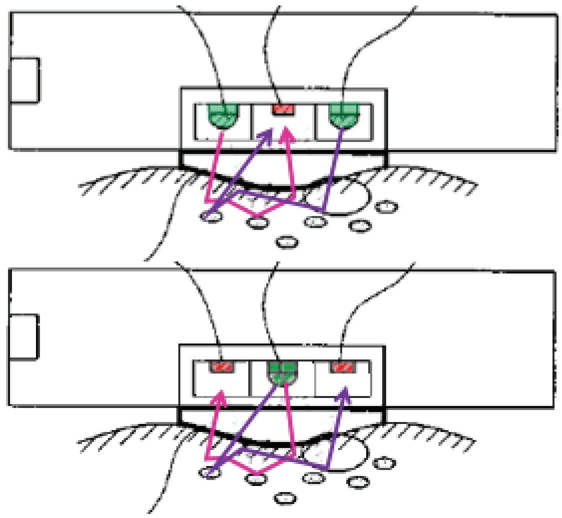
37. When factoring in additional scattering that may occur when light is reflected within human tissue, reversibility holds for each of the rays that are not completely absorbed; consequently, "if we're concerned with the impact of the lens on the system, it's absolutely reversible." APPLE-1062, 209:19-21, 207:9-209:21 ("one could look at any particular randomly scattered path…and the reversibility principle applies to all of the pieces [of that path] and, therefore, applies to the aggregate").

38. An example of reversibility in a situation with diffuse light, such as is present when LEDs illuminate tissue, is shown below from Hecht's Figure 4.12.

Figure 4.12 (a) Specular reflection. (b) Diffuse reflection. (Photos courtesy Donald Dunitz.)

39. In this figure 4.12a, collimated light is incident on a smooth surface, and exhibits specular reflection, in which parallel light rays encounter and are reflected from the surface and remain parallel. A POSITA would certainly understand specular reflection. In the case of the reflection as shown in Figure 4.12b, the random roughness of the surface scatters the incoming rays into many directions, and the resulting light would appear to be diffuse. However, even in this circumstance, the principle of reversibility applies–each individual ray can be reversed such that a ray travelling to the surface and scattered in a random direction can be followed backwards along exactly the same path.

40. In more detail, and as shown with respect to the example paths illustrated below (which include scattering within tissue), each of the countless photons travelling through the system must abide by Fermat's principle. APPLE-1052, 106-111. Consequently, even when accounting for various random redirections and partial absorptions, each photon traveling between a detector and an LED would take the quickest (and identical) path along the segments between each scattering event, even if the positions of the detector and LED were swapped.



41. To better understand the effect of a convex lens on the propagation of light rays towards or away from the different LEDs or detectors, the first and last segment of the light path may be representative of the light propagation of the various light rays. In the figures above, starting at the upper left, there is a pink-colored light ray emerging from the green LED and passing through the convex lens and entering the tissue. On the lower left, there is a pink-colored light ray leaving the tissue and entering the convex lens. As drawn, these rays are the same in position and orientation, except that the direction is exactly reversed. This illustration is consistent with the Principle of Reversibility as applied to this pair of possible light rays. According to the principle of reversibility, the upper light path from the LED to the first interaction with a corpuscle is exactly reversed. This same behavioral pattern applies to all of the segments of the many light paths that cross the interface at the surface of the convex lens. Importantly, in this example, the convex lens does not refract the incoming ray in a different direction from the outgoing ray, e.g., in a

direction towards the center different from the outgoing ray. As required by the principle of reversibility, this incoming ray follows the same path as the outgoing ray, except in the reverse direction. This statement is true for every segment of these light paths that crosses the interface between the tissue and the convex lens. Any ray of light that successfully traverses a path from the LED to the detector, that path already accounts for the random scattering as that scattering is what allowed the ray to go from the LED to a detector along the path to thereby be subsequently detected by the detector. A POSITA would have understood that the path is an aggregation of multiple segments and that the path is reversible as each of its segments would be reversible, consistent with Fermat's principle.

42. The statement about the reversibility of the segments of the light path which cross the interface between tissue and convex lens is consistent with the well-known and well-established Snell's law, which provides a simple algebraic relation between the angles of incidence and refraction as determined by the two indices of refraction. And Snell's law supports the basic understanding that the path of the light rays to/from a scattering event across the interface to/from the convex lens and on to/from the LED or photodetector must be reversible.

43. Based on this understanding of light rays and Snell's law, a POSITA would have understood that the positions of the emitters and detectors can be swapped in the proposed combination, and that the light paths from the initial situation would be reversed in the altered situation.

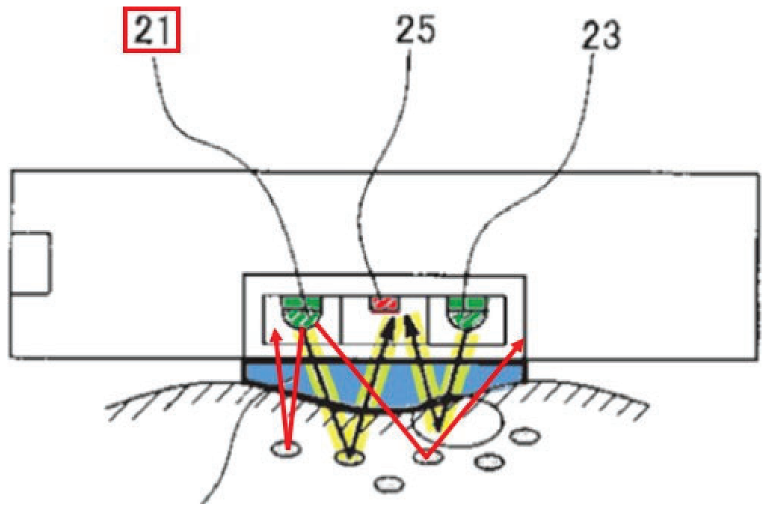
44. When confronted with this basic principle of reversibility during deposition, Dr. Madisetti refused to acknowledge it, even going so far as to express ignorance of "Fermat's principle, ***whatever that is***." APPLE-1054, 89:12-19. Yet Fermat's principle, which states that a path taken by a light ray between two points is one that can be traveled in the least time, regardless of the direction of travel, is one of the most fundamental concepts in optics/physics and plainly requires the basic principle of reversibility. APPLE-1051, 87-92; APPLE-1052, 106-111. Dr. Madisetti further tried to brush away the applicability of this principle as being a "new theory." Id., 84:2- 85:7. But far from being a new theory, this core concept dates back many years, and is offered in Aizawa itself. Indeed, ***Aizawa recognizes this reversibility***, stating that while the configurations depicted include a central emitter surrounded by detectors, the "same effect can be obtained when…a plurality of light emitting diodes 21 are disposed around the photodetector 22." APPLE-1006, [0033]; APPLE-1055, 209:19-21.

45. In short, based at least on the principle of reversibility, a POSITA would have understood that both configurations of LEDs and detectors—*i.e.*, with the LED at the center as in Aizawa or with the detector at the center as in Inokawa—would identically benefit from the enhanced light-gathering ability of a convex lens/protrusion.

ii. Masimo ignores the behavior of scattered light in a reflectance-type pulse sensor

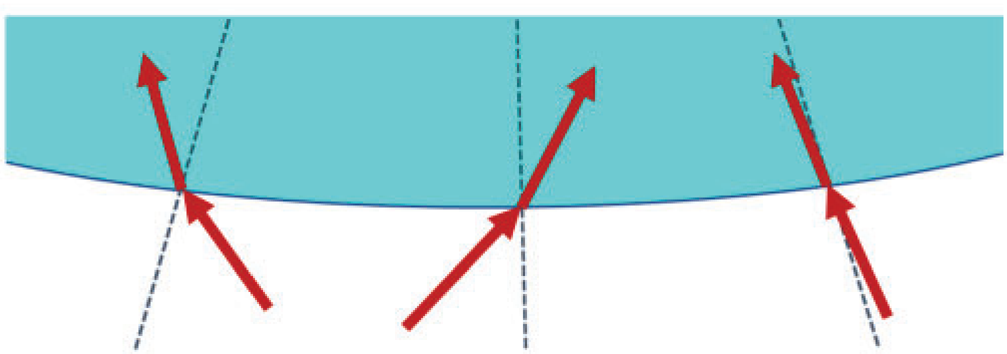
46. Because Aizawa is a reflectance-type pulse sensor that receives diffuse, backscattered light from the measurement site, its cover/lens cannot focus all incoming light toward the sensor's center. Ex. 2006, 163:12-164:2 ("A lens in general…doesn't produce a single focal point"). Indeed, reflectance-type sensors work by detecting light that has been "partially reflected, transmitted, absorbed, and scattered by the skin and other tissues and the blood before it reaches the detector." APPLE-1021, 86. A POSITA would have understood that light which backscatters from the measurement site after diffusing through tissue reaches the active detection area from various random directions and angles. APPLE-1056, 803; APPLE-1021, 90, 52.

47. As noted above, basic law of refraction, namely Snell's law, dictates this behavior of light. APPLE-1051, 84; APPLE-1052, 101; APPLE-1053, 80:20-82:20; APPLE-1021, 52, 86, 90. For example, referring to Masimo's version of Inokawa's FIG. 2, further annotated below to show additional rays of light emitted from LED 21, it is clearly seen how some of the reflected/scattered light from the measurement site does not reach Inokawa's centrally located detector:



APPLE-1008, FIG. 2 (annotated); POR, 14.

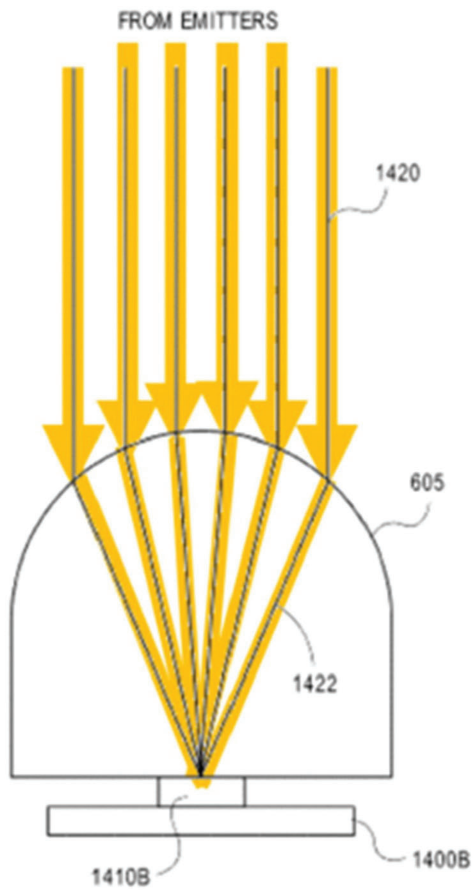
48. For these and countless other rays that are not shown, there is simply no way for a cover to focus all light at the center of the sensor device. APPLE-1051, 84; APPLE-1052, 101; APPLE-1053, 80:20-82:20. The illustration I provide below shows how Snell's law determines a direction of a backscattered ray within a convex cover, thus providing a stark contrast to Masimo's assertions that all such rays must be redirected to or towards the center:



49. Indeed, far from focusing light to the center as Masimo contends, Ohsaki's

convex cover provides a slight refracting effect, such that light rays that may have otherwise missed the detection area are instead directed toward that area as they pass through the interface provided by the cover. This is particularly true in configurations like Aizawa's in which light detectors are arranged symmetrically about a central light source, so as to enable backscattered light to be detected within a circular active detection area surrounding that source. APPLE-1021, 86, 90. The slight refracting effect is a consequence of the similar indices of refraction between human tissue and a typical cover material (e.g., acrylic). APPLE-1057, 1486; APPLE-1058, 1484).

50. To support the misguided notion that a convex cover focuses all incoming light at the center, Masimo relies heavily on the '553 patent's FIG. 14B (reproduced below):



APPLE-1001, FIG. 14B (as annotated at POR, 40)

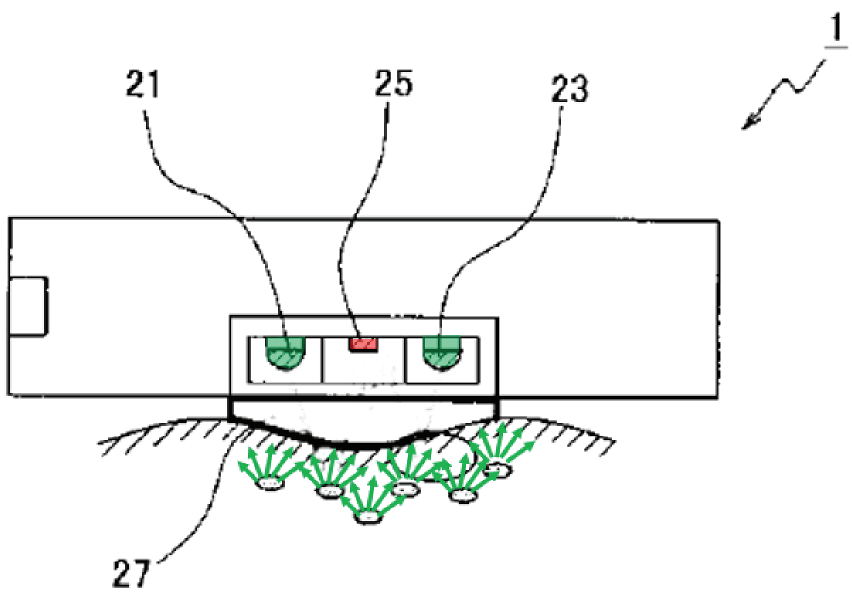
51. Masimo and Dr. Madisetti treat this figure as an illustration of the behavior of all convex surfaces with respect to all types of light, and conclude that "a convex surface condenses light away from the periphery and towards the sensor's center." POR, 40; APPLE-1052, 56:9-60:2; APPLE-1054 ("…a POSA viewing [FIG. 14B]…would understand that light, ***all light***, light from the measurement site is being focused towards the center").

52. But the incoming collimated light shown in FIG. 14B is not an accurate representation of light that has been reflected from a tissue measurement site. The light rays (1420) shown in FIG. 14B are collimated (i.e., travelling paths

parallel to one another), and each light ray's path is perpendicular to the detecting surface.

53. By contrast, the detector(s) of reflectance type pulse detectors detect light that has been "partially reflected, transmitted, absorbed, and scattered by the skin and other tissues and the blood before it reaches the detector." APPLE-1021, 86. For example, a POSITA would have understood from Aizawa's FIG. 1(a) that light that backscatters from the measurement site after diffusing through tissue reaches the circular active detection area provided by Aizawa's detectors from various random directions and angles, as opposed to all light entering from the same direction and at the same angle as shown above in FIG. 14B. APPLE-1021, 52, 86, 90; APPLE-1059, 803-805; *see also* APPLE-1012, FIG. 7. Even for the collimated light shown in FIG. 14B, the focusing of light at the center only occurs if the light beam also happens to be perfectly aligned with the axis of symmetry of the lens. *See* Ex. 2007, 298:11-299:1. If for example, collimated light were to enter the FIG. 14B lens at any other angle, the light would focus at a different location in the focal plane. Further, if the light were not collimated, so that rays enter the lens with a very wide range of incident angles, there would be no focus at all, and many rays will be deflected away from the center. Moreover, since "the center" takes up a very small portion of the total area under the lens, the majority of rays associated with diffuse light entering the lens would arrive at locations away from the center.

54. The light rays from a diffuse light source, such as the LED-illuminated tissue near a pulse wave sensor or a pulse oximeter, include a very wide range of angles and directions, and cannot be focused to a single point/area with optical elements such as lenses and more general convex surfaces. The example figure below illustrates light rays backscattered by tissue toward a convex lens; as consequence of this backscattering, a POSITA would have understood that the backscattered light will encounter the interface provided by the convex board/lens at all locations from a wide range of angles. This pattern of incoming light cannot be focused by a convex lens towards any single location.



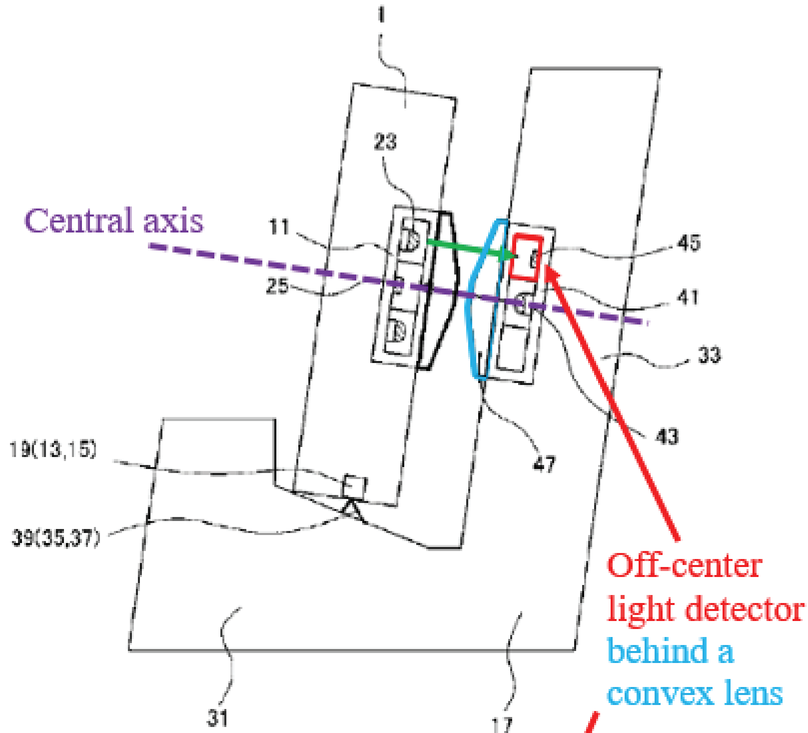
APPLE-1051, 141 (annotated)

55. To the extent Masimo contends that only *some* light is directed "towards the center" and away from Aizawa's detectors in a way that discourages combination, such arguments also fail. Indeed, far from *focusing* light to a single central point, a POSITA would have understood that Ohsaki's cover provides a

slight refracting effect, such that light rays that may have missed the active detection area are instead directed toward that area as they pass through the interface provided by the lens. APPLE-1021, 52; APPLE-1007, [0015]; APPLE-1051, 87-92, 135-141; APPLE-1054, 60:7-61:6, 70:8-18.

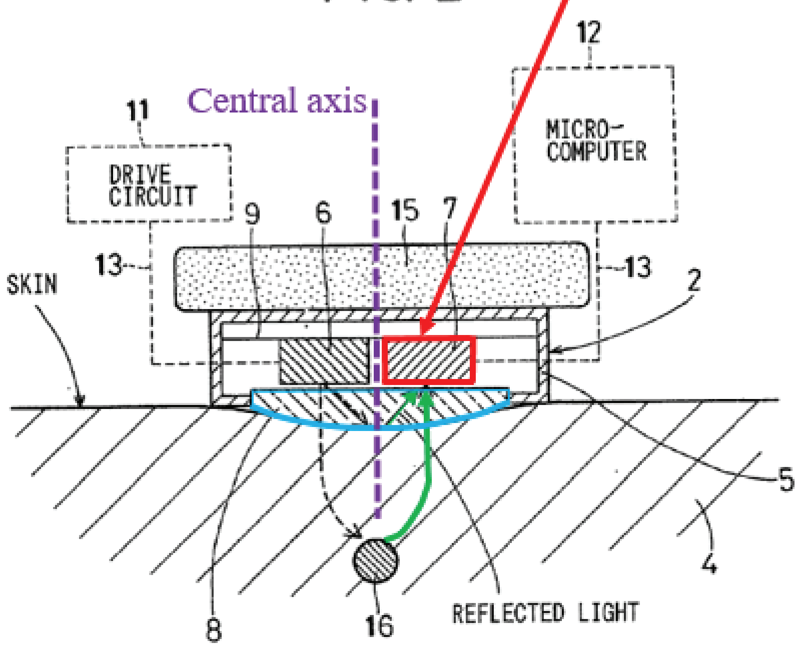
56. Masimo's technically and factually flawed argument is exposed by multiple prior art references, including the Ohsaki and Inokawa references which are the key elements of our combinations. As shown in the figures below, Ohsaki and Inokawa both show embodiments which use a convex lens to direct light to detectors that are not located at the center of a sensor. APPLE-1009, FIG. 2; APPLE-1008, FIG. 3. In Inokawa's Figure 2, an off-center emitter and sensor are configured to send and receive text messages, and are capable of success, even though the detector is not positioned at the center.

(FIG. 3)



APPLE-1008, FIG. 3

FIG. 2

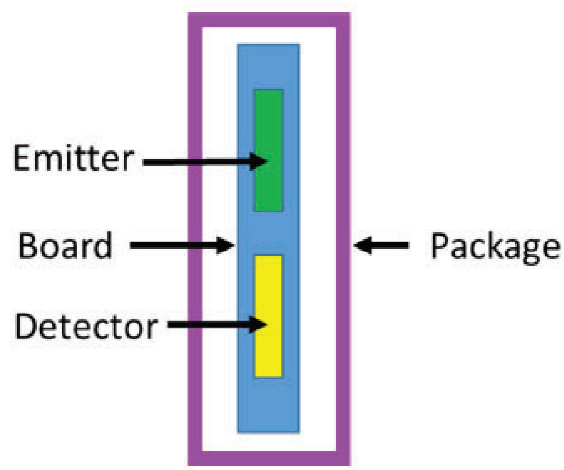


APPLE-1009, FIG. 2

57. If, as asserted by the Patent Owner, a convex lens is required to condense,

direct, or focus the light to the center, the embodiments disclosed by Ohsaki and Inokawa would all fail because there is no detector at the center to detect all of the light that would be directed towards the center by the convex board. The Ohsaki and Inokawa embodiments (reproduced above) do not show or otherwise teach that its convex board directs all light towards the center.

58. Moreover, even in Patent Owner and Dr. Madisetti's illustration (shown below), which represents their understanding of Ohsaki's FIGS. 1 and 2, the detector is not located in the center. EX. 2004, ¶38. If Patent Owner and Dr. Madisetti's arguments were correct (which they are not), Ohsaki embodiments in FIGS. 1 and 2 would fail to produce a functioning pulse wave sensor—which is not the case—and Patent Owner has never claimed the same either.



EX. 2004, pg. 22

59. For all of these reasons, including details from the interpretation of Ohsaki's embodiment provided by Dr., Madisetti and the Patent Owner, it would have been obvious to a POSITA that a convex cover would have been

successfully used with a sensor design with peripheral detectors (as in Aizawa and Ohsaki), and that it would be reasonable to expect the benefits of improved adhesion as explained above and in my previous declaration.

D. A POSITA would have been motivated to select a convex cover to protect the optical elements

60. Masimo contends that "a POSITA would have understood that Aizawa's flat plate would provide better protection than a convex surface" and be "less prone to scratches." POR, 45-46. Even assuming this to be true, one possible disadvantage that competes with the known advantages of applying Ohsaki's teachings to Aizawa's sensor would not have negated a POSITA's motivation to combine. Moreover, a POSITA would have understood the ***multiple*** advantages of a convex cover described in my earlier declaration outweigh any alleged possibility of scratching (which, at any rate, has nothing whatsoever to do with the protection of optical elements within Aizawa's sensor). Moreover, by choosing a suitable material of the protrusion to be scratch-resistant, such as glass, it would have been obvious for a POSITA to achieve both benefits (light gathering and scratch-resistance) at once.

E. A POSITA would have combined Aizawa and Ohsaki with Goldsmith

61. The POR advances no substantive arguments regarding the Aizawa-Ohsaki-Goldsmith combination, and instead merely states that "Petitioner does

not argue Goldsmith cures the deficiencies in its proposed combination of Aizawa and Ohsaki," and "[t]hus…fails to show that Aizawa, Ohsaki, and Goldsmith together render claim 1 obvious." POR, 46. The POR's statement is irrelevant, and also mischaracterizes the Petition, which provided many pages of explanation with respect to the combination. Petition, 25-41.

F. The claimed protrusion height in claims 16 and 17 would have been obvious to a POSITA

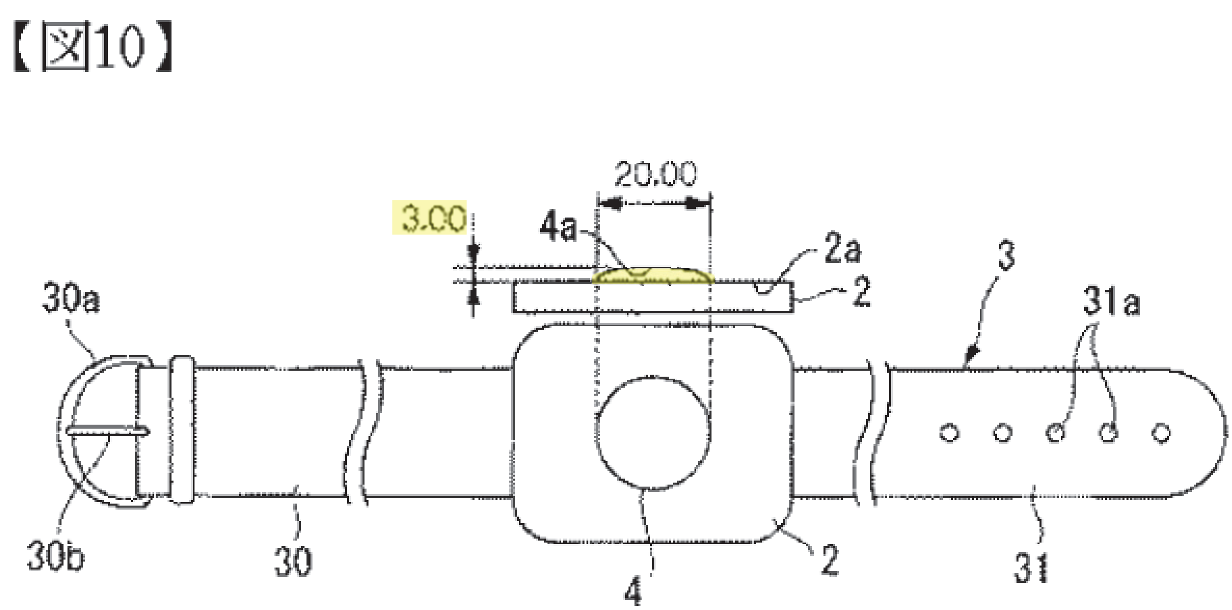
62. The POR argues that nothing in the references teaches or suggests that a protrusion with the claimed height in claims 16 and 17 would have been obvious, and dismisses the prior art mapping for claims 16 and 17 as hindsight based. POR, 47-48. As explained below, the POR ignores evidence establishing the obviousness of the claimed dimensions, and further mischaracterizes arguments in my earlier declaration and the disclosure of the references.

63. For example, Mendelson 2006 and Mendelson 1988 indicate the relative sizes (e.g., ~13 x 13 mm) of sensors as of the Critical Date (these references are not relied upon for any alleged disclosure of a cover). APPLE-1003, ¶147; Petition, 78. Even Patent owner acknowledges that Mendelson 2006 and Mendelson 1988's sensors are "***similarly sized sensors***." POR, 48. Moreover, the POR mischaracterizes the Mendelson sensors as being limited to forehead sensors. POR, 48. In fact, Mendelson 2006 expressly teaches that "in reflection pulse oximetry, the LEDs and PD are both mounted side-by-side on the same

planar substrate to enable readings ***from multiple body locations***" and repeatedly describes its sensor as "a ***body-worn*** pulse oximeter," which would suggest to a POSITA that Mendelson 2006's sensor is not limited to a forehead sensor, as asserted by the POR. APPLE-1010, 912, 913; *see also* APPLE-1014, 167 ("skin reflectance oximetry could enable SpO2 measurement from more centrally located parts of the body such as the forearms, chest, and forehead").

64. Similarly, Kondo indicates sizes and designs of protrusions in optical sensors as of the Critical Date; by its indication of a deformation depth of about 2-20 mm due to a protrusion, Kondo further supports that a protrusion of the claimed range would have been obvious.

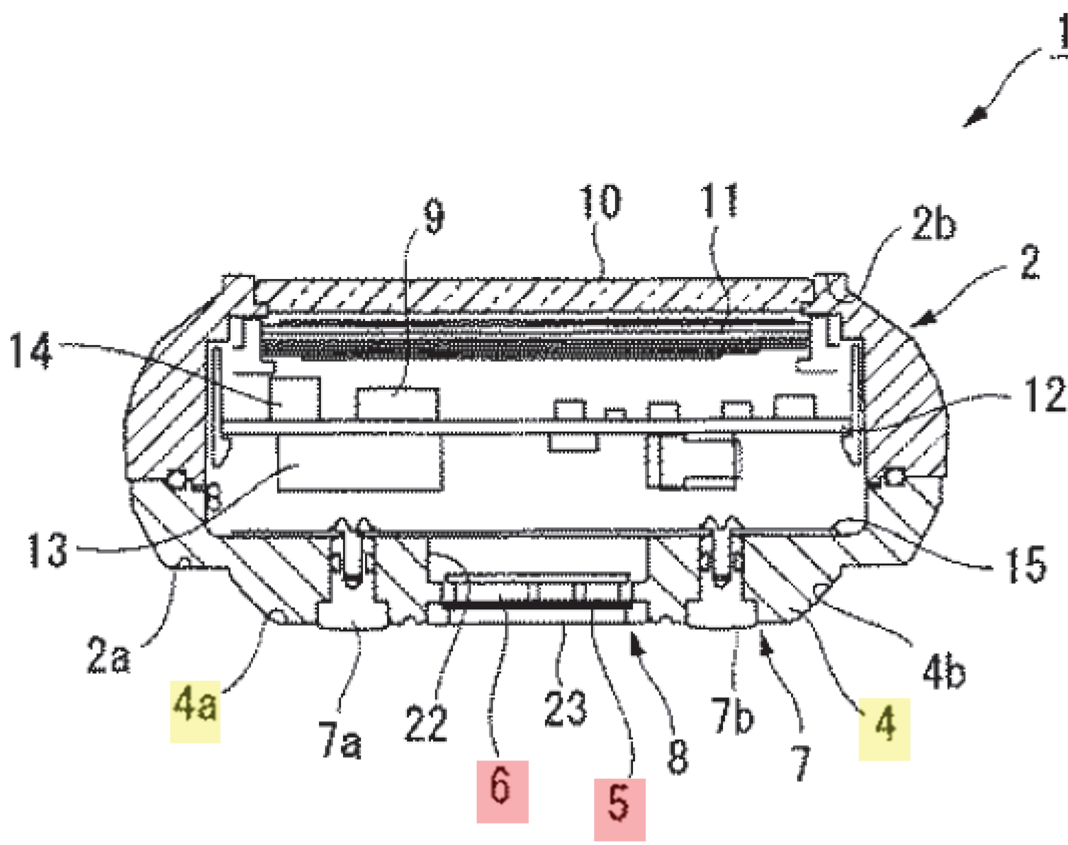
65. Moreover, Tanagi clearly discloses a protrusion of 3 mm (within the claimed range) as evidenced by Tanagi's figures shown below. APPLE-1026, FIGS. 8-10, ¶¶74-81.



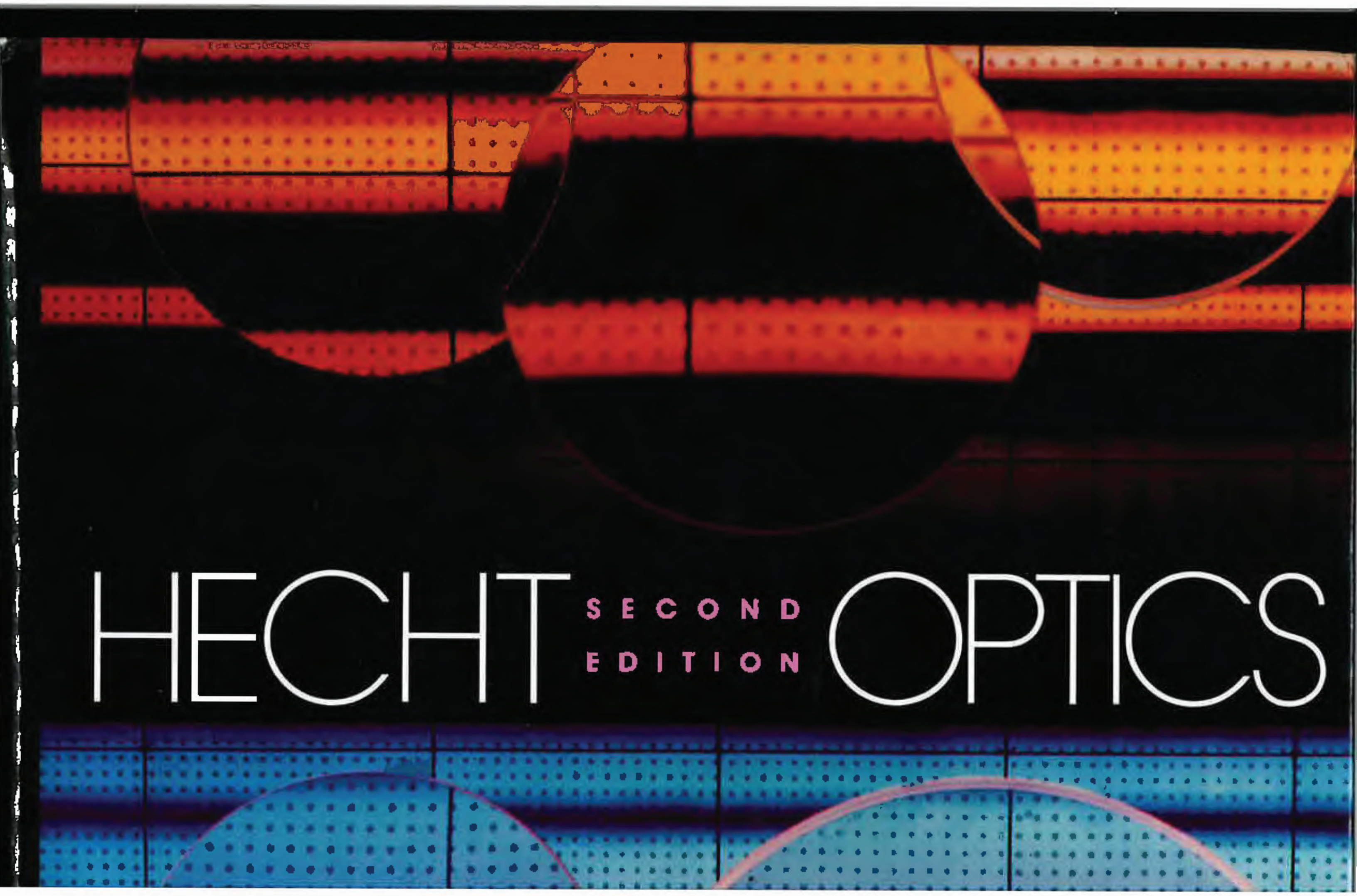
APPLE-1026, FIG. 10 (*see also* FIGS. 8, 9)

66. In an attempt to persuade the Board to disregard this disclosure, the POR points to unrelated Tanagi embodiments (FIGS. 5-7, *see* APPLE-1026, ¶¶72-73) and argues that Tanagi's disclosure should not be considered because the LED and photodetector are placed on top of the "convex surface." POR, 49-50. Yet, even if these other embodiments were to be considered, Tanagi's FIG. 7 (reproduced below) clearly illustrates that the lower surface 4a of the protrusion 4 is at approximately the same height, if not greater, than the LED 5 and the PD 6.

【図7】



APPLE-1026, FIG. 7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OPTICS

remaining two sides, that is,

$$\frac{\overline{SC}}{\overline{SA}}=\frac{\overline{CP}}{\overline{PA}}. \tag{5.48}$$

Furthermore,

$$\overline{SC}=s_o-|R| \quad \text{and} \quad \overline{CP}=|R|-s_i,$$

where s_o and s_i are on the left and therefore positive. If we use the same sign convention for R as we did when we dealt with refraction, it will be negative here, because C is to the left of V (i.e., the surface is concave). Thus $|R|=-R$ and

$$\overline{SC}=s_o+R \quad \text{and} \quad \overline{CP}=-(s_i+R).$$

In the paraxial region $\overline{SA}\approx s_o$, $\overline{PA}\approx s_i$, and so Eq. (5.48) becomes

$$\frac{s_o+R}{s_o}=-\frac{s_i+R}{s_i}$$

or

$$\frac{1}{s_o}+\frac{1}{s_i}=-\frac{2}{R}, \tag{5.49}$$

which is often referred to as the **mirror formula**. It is equally applicable to concave ($R<0$) and convex ($R>0$) mirrors. The primary or object focus is again defined by

$$\lim_{s_i\to\infty} s_o=f_o,$$

and the secondary or image focus corresponds to

$$\lim_{s_o\to\infty} s_i=f_i.$$

Consequently, from Eq. (5.49)

$$\frac{1}{f_o}+\frac{1}{\infty}=\frac{1}{\infty}+\frac{1}{f_i}=-\frac{2}{R},$$

to wit, $f_o=f_i=-R/2$, as we know from Fig. 5.45(c). Thus, dropping the subscripts on the focal lengths, we have

$$\frac{1}{s_o}+\frac{1}{s_i}=\frac{1}{f}. \tag{5.50}$$

Observe that f will be positive for concave mirrors ($R<0$) and negative for convex mirrors ($R>0$). In the latter instance the image is formed behind the mirror and is virtual (Fig. 5.50).

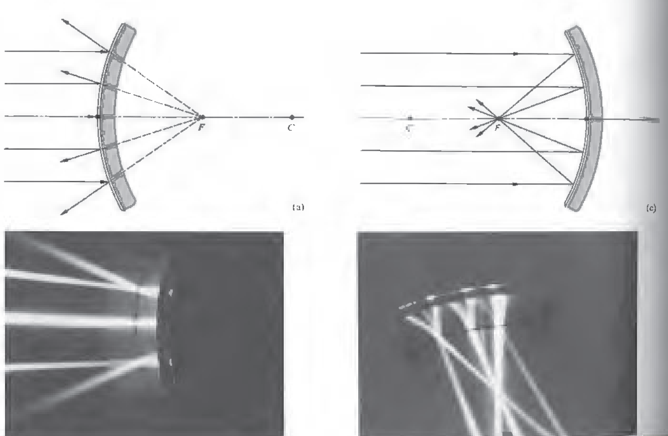

Figure 5.50 Focusing of rays via a spherical mirror. (Photos by E.H.)

iii) Finite Imagery

The remaining mirror properties are so similar to those of lenses and spherical refracting surfaces that we need only mention them briefly, without repeating the entire optical development of each item. Within the restrictions of paraxial theory, any parallel off-axis bundle of rays will be focused to a point on the *focal plane* passing through F normal to the optical axis. Likewise, a finite planar object perpendicular to the optical axis will be imaged (to a first approximation) in a plane similarly situated. Essentially we are saying that each object point has a corresponding image point in the plane. This is certainly true for a plane mirror, but it only approximates the case for other configurations. To be sure, if a spherical mirror is appropriately restricted in its operation, the reflected waves arising from each permitted object point will closely approximate spherical waves. Under such circumstances good finite images of extended objects can be formed (Fig. 5.51). Just as each image point produced by a thin lens lies along a straight line through the optical center O, each image point for a spherical mirror will lie on a ray passing through both the center of curvature C and the object point. As with the thin lens (Fig. 5.24), the graphic location of the image is quite straightforward. Once more the top of the image is located at the intersection of two rays, one initially parallel to the axis and passing through F after reflection, and the other going straight through C (Fig. 5.52). The ray from any off-axis object point to the vertex forms equal angles with the optical axis on reflection and is therefore particularly convenient to construct as well. So too is the ray that first passes through the focus and after reflection emerges parallel to the axis.

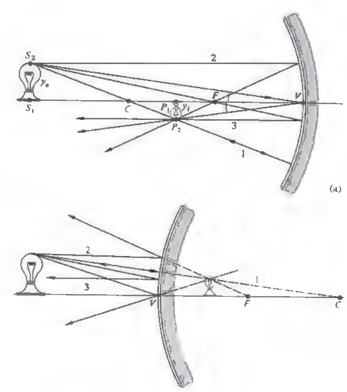

Figure 5.51 Finite imagery with spherical mirrors.

Notice that triangles S_1S_2V and P_1P_2V in Fig. 5.51(a) are similar, and hence their sides are proportional. Taking y_i to be negative, as we did before, since it is below the axis, we find that $y_i/y_o=-s_i/s_o$, which of

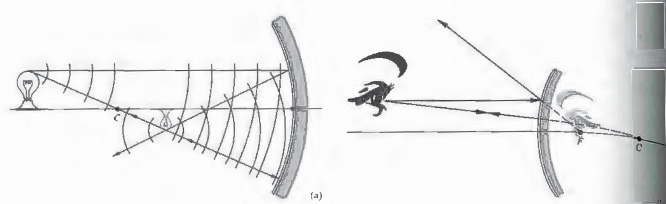

Figure 5.52 (a) Reflection from a concave mirror. (b) Reflection from a convex mirror.

course is equal to M_T, the *transverse magnification*, identical to that of the lens (5.25).

The only equation that contains information about the structure of the optical element (n, R, etc.) is that for f, and so, rather understandably, it differs for the thin lens and spherical mirror. The other functional expressions that relate s_o, s_i, and f or y_o, y_i, and M_T are, however, precisely the same. The only alteration in the previous sign convention appears in Table 5.4, where s_i on the left of V is now taken as positive. The striking similarity between the properties of a concave mirror and a convex lens on one hand and a convex mirror and a concave lens on the other are quite evident from a comparison of Tables 5.3 and 5.5, which are identical in all respects.

The properties summarized in Table 5.5 and depicted pictorially in Fig. 5.53 can easily be verified empirically. If you don't have a spherical mirror at hand, a fairly crude but functional one can be made by carefully

Table 5.4 Sign convention for spherical mirrors.

Quantity	Sign	
	+	−
s_o	Left of V, real object	Right of V, virtual object
s_i	Left of V, real image	Right of V, virtual image
f	Concave mirror	Convex mirror
R	C right of V, convex	C left of V, concave
y_o	Above axis, erect object	Below axis, inverted object
y_i	Above axis, erect image	Below axis, inverted image

Table 5.5 Images of real objects formed by spherical mirrors.

Concave				
Object	Image			
Location	Type	Location	Orientation	Relative size
$\infty > s_o > 2f$	Real	$f < s_i < 2f$	Inverted	Minified
$s_o = 2f$	Real	$s_i = 2f$	Inverted	Same size
$f < s_o < 2f$	Real	$\infty > s_i > 2f$	Inverted	Magnified
$s_o = f$		$\pm\infty$		
$s_o < f$	Virtual	$\lvert s_i \rvert > s_o$	Erect	Magnified
Convex				
Object	Image			
Location	Type	Location	Orientation	Relative size
Anywhere	Virtual	$\lvert s_i \rvert < \lvert f \rvert$, $s_o > \lvert s_i \rvert$	Erect	Minified

shaping aluminum foil over a spherical form, su the end of a light bulb (in that particular case R therefore f will be small). A rather nice qu experiment involves examining the image of some object formed by a short focal-length concave As you move it toward the mirror from beyond a tance of $2f = R$, the image will gradually increase, at $s_o = 2f$ it will appear inverted and life-size. Brin it closer will cause the image to increase even m until it fills the entire mirror with an unrecogni blur. As s_o becomes smaller, the now erect, magn image will continue to decrease until the object fi rests on the mirror, where the image is again life

If you are not moved by all of this to jump up and make a mirror, you might try examining the image formed by a shiny spoon—either side will be interesting.

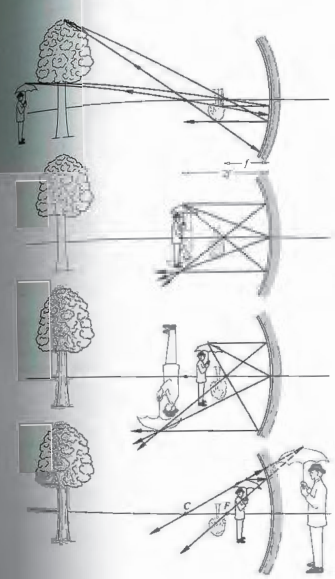

Figure 5.53 The image-forming behavior of a concave spherical mirror.

5.5 PRISMS

Prisms have many different roles in optics; there are prism combinations that serve as beam-splitters (see Section 4.3.4), polarizing devices (see Section 8.4.3), and even interferometers. Despite this diversity, the vast majority of applications make use of only one of two main prism functions. First, a prism can serve as a dispersive device, as it does in a variety of spectrum analyzers. That is to say, it is capable of separating, to some extent, the constituent frequency components in a polychromatic light beam. You might recall that the term *dispersion* was introduced earlier (Section 3.5.1) in connection with the frequency dependence of the index **of refraction, $n(\omega)$, for dielectrics. In fact, the prism provides a highly useful means of measuring $n(\omega)$ over a broad range of frequencies and for a wide variety of materials (including gases and liquids). Its second and more common function is to effect a change in the orientation of an image or in the direction of propagation of a beam. Prisms are incorporated in many optical instruments, often simply to fold the system into a** confined space. There are inversion prisms, reversion prisms, and prisms that deviate a beam without inversion or reversion—and all of this without dispersion.

5.5.1 Dispersing Prisms

Nowadays prisms come in a great variety of sizes and shapes and perform an equally great variety of functions (Fig. 5.54). Let's first consider the group known as **dispersing prisms. Typically, a ray entering a dispersing prism,** as in **Fig. 5.55, will emerge having been deflected** from **its original direction by an angle δ known** as the *angular deviation*. At the first refraction the ray is deviated through an angle $(\theta_{i1} - \theta_{t1})$, and at the second refraction it is further deflected through $(\theta_{t2} - \theta_{i2})$. The total deviation is then

$$\delta = (\theta_{i1} - \theta_{t1}) + (\theta_{t2} - \theta_{i2}).$$

Since the polygon $ABCD$ contains two right angles, $\measuredangle BCD$ must be the supplement of the *apex angle* α. As the exterior angle to triangle BCD, α is also the sum